Mining

"MINING,"

AN ILLUSTRATED PAPER DEALING EXCLUSIVELY WITH THE INTERESTS OF THE MINING COMMUNITY.

VOLUME III.—1894-95.

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MINING

A JOURNAL DEVOTED TO THE INTERESTS OF MINI…

No. 1. Vol. III. SATURDAY, DECEMBER 1, 1894. FORTNIGHTLY. ONE PENNY.

CONTENTS

EASY LESSONS ON MINE SURVEYING

For Beginners.

Commenced in No. 2, Volume II.

RACKING OR FAST-NEEDLE DIALLING.

FAST-NEEDLE dialling is usually adopted where the presence of iron renders the use

FIG. 84.

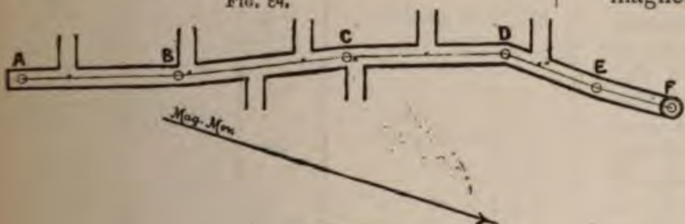

FIG. 85.

of the needle impracticable, and, as it is not always possible to tell whether a station is suitable for a loose needle bearing many surveyors prefer to take fast-needle diallings almost exclusively, merely checking the survey from time to time with the needle, where a correct needle bearing is deemed possible.

In fast-needle diallings, as in the "correcting deflection" method, it is necessary to have one line whose correct magnetic bearing is known, from which to reduce the fast-needle bearings.

There are various methods of racking in use, the one used by the writer by reason of its numerous advantages being explained by the following description. The method consists in finding the magnetic meridian by means of the loose needle and using this as a base line for the subsequent angles. The special advantages of this method are, the magnetic bearing is read off immediately, without resource to calculations, and the survey can be checked at any point where a loose needle bearing is possible, and it can be seen at a glance whether the work has been done correctly or not. The description will in all probability be simplified by taking a possible example of a survey made by this method.

Assuming a survey be required of the road shown by fig. 84. The survey is commenced at one extremity where it is possible to obtain a true magnetic bearing with the needle, this may be in an old disused road near the shaft or as in the example referred to at the point A at the inbye extremity of the road. The dial is set up at A and the needle is allowed to

assume its true position—that is in the magnetic north and south line; the dial is now gently turned until the zero of the vernier exactly coincides with the north end of the needle, and the dial is clamped in this position on the legs by means of the screw *(f)* fig. 68*; we thus obtain a base line from which the remainder of the survey may be worked. The peg *(e)* is now taken out and the sights are adjusted to the light held at B by turning the tangent screw *(b)*, and are clamped in this position by the small screw *(d)* which prevents the two main plates of the dial from rotating. The position of the vernier is now read off (in a manner which will be described) and the dial is moved to the legs at B at which the light was held; the vernier being retained in its new position. The dial is now adjusted to a light held at A, the south end of the dial being towards the light and clamped on the legs by the screw *(b)* as before. The two plates of the dial are now unclamped by unscrewing *(d)* and the sights are adjusted towards C and again clamped by *(d)*, and the reading of the vernier is taken; in this manner any number of bearings may be taken, and it is advisable at the termination of the survey or any other suitable position to allow the needle to settle in its course after having previously removed any material which is likely to attract it and thus obtain a check upon the angling. If the survey has been correctly made the needle should settle at any station where it is not attracted exactly in the north and south line of the graduated circle. The reading of the dial by this method is different to the manner in which a bearing is read in a loose needle survey in an important detail; for whereas in loose needle surveying the east and west of the dial are on the sides contrary to the geographical position, by this method the bearings must be read as if the east and west were in the ordinary position; thus, if the vernier reading of the dial is N 20 W, then it must be booked as N 20 E, or if S 6 E as S 6 W, and if the outer graduations which are consecutive from 0° to 360° are read, then care must be taken that the protractor is graduated in the same direction as the dial; perhaps the best method is to read off the bearings with the cardinal points N S E W, as it is so simple a matter to transpose the E and W.

Fig. 85 shows the two positions which the vernier and sights will occupy at the commencement of the survey, viz.:—A. The dotted lines show the position of the vernier and sights as adjusted to coincide with the needle, and the firm lines show the position which they occupy when taking the sight to B after the dial has been clamped on the legs.

The following shows the bookings of the survey:—

	192	To winding shaft.
No. 5 N 2-9 W	0	
	116	
Cut-through	40	
No. 4 N 3-45 E	0	
	195	
Cut-through	96	
	10	Downbrow Place.
No. 3 N 17-57 W	0	
	206	
Cut-through	151	
	64	Downbrow Place.
Cut-through	12	
No. 2 N 23-6 W	0	
	186	Permanent mark left.
Cut-through	54	
No. 1 N 18-2 W	0	From face of level.

Another method which is sometimes used is to make the first line of sight the base-line and to calculate the meridian angles afterwards; by this method it is immaterial whether the loose needle bearing is the first sight or not. A back observation is taken along the first line of sight with the vernier at zero, and the dial is clamped in this position on the legs; a base line is thus formed which coincides with the first line of sight which is booked as 0 0 and the remainder of the survey is

* See No. 20, Vol. II.

done in a similar manner to the one previously described, but the readings are as shown on the dial and do not require transposing.

There is still another method which consists in taking the angle which each bearing makes with the one immediately preceding; by this method, after the angle has been obtained, the vernier is put back to zero in each case, before taking the back observation.

The following is the rule for reducing the angles taken by this system:—Add the first meridian angle to the next observed angle, and if this sum is less than 180° add that amount to it, if more than 180° deduct that amount; the meridian angle of the second observation is then obtained. If the angle should exceed 360° after following out the above rule, then that amount must be deducted to obtain the angle.

Suppose the following angles to have been taken (1) 00; (2) 60; (3) 122; (4) 206.

Then to reduce the angles to the base line proceed thus:—

(1) 00 = base line.
(2) 60 This angle is unaltered as it is taken from the base.
(3) 60+122=182.
182-180 = 2°
(4) 2+206 = 208.
208-180 = 28°

If these angles from the base line were required to be reduced to meridian angles and the meridian angle of the base line was known, then this meridian angle must be added to the previous angles and the meridian angle of each bearing will be thus obtained.

Although for the sake of simplicity minutes have not been recorded in the example given, yet these should be read off with the vernier in actual practice; especially is this necessary in the last method described, as a quarter of a degree of an error in the reading of one sight also causes an error of this amount in every successive sight and the error is thus multiplied. This is one of the disadvantages of this system which does not occur in the others. The first method is by far the best for almost all underground purposes, and a survey may be made to any degree of accuracy.

In fast-needle surveying three sets of legs together with cups for the lamps should be always employed, as the accuracy of the work depends upon keeping the exact position of a station during a fore and back observation. The speed and facility also with which the work can be done renders them very useful.

(*To be continued.*)

COMPETITION QUESTIONS.

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3.—Correct name and postal address must be sent.

4.—They must reach us by December 14th, 1894.

5.—The Editor's decision as to winners to be final.

ELEMENTARY.

Question 1.—Give a description with dimensions of the various tools used underground.

ADVANCED.

Question 2.—Describe the various methods employed in mining operations for transmitting power. Discuss the efficiency of the more important, and the special circumstances under which each are applied.

FIRST-CLASS.

Question 3.—Give a detailed description of a method of haulage with which you are acquainted, giving dimensions of engine, etc., length of roads, quantity of coal hauled, etc. Give sketches.

AWARDS

FOR ANSWERS TO COMPETITION QUESTIONS.—No. 1 SET.

ELEMENTARY.—C. Barron, Copley, Butterknowle, Darlington.

Commended—N. Dunscombe, T. Thomas, F. Cherry, J. Finch, J. H. Senior, M. Collinson. G. D. Dobinson, G. Tweddell, D. Turner, T. D. Stuart, G. Bell, J. Wheatcroft, T. E. Quail, J. T. Ward.

ADVANCED.—G. Brown, Butterknowle, Darlington.

Commended.—J. Walsh, S. Davies, G. Hugill, W. Pace, S. Chadwick, J. Crone, J. Thompson, A. Gowdey, J. H. Rhodes.

FIRST-CLASS.—J. Jackson, 28, Ellesmere Street, Leigh, Lancashire.

Commended.—W. Slocombe, A. Alderson, J. Hardman, J. McPhail, J. Stephenson, G. Daykin, M. Brown, D. Chapman, J. Worrall, A. H. Meakin, J. Harrison, D. Spence, J. Smith, T. E. Aitchison, G. A. Lodge, T. Lawrenson, A. Hart, J. Fox, M. Lonsdale, J. H. Sherman.

CORRESPONDENCE UNAVOIDABLY HELD OVER.

CRITICISM ON THE COLLIERY MANAGERS' EXAMINATIONS.

IN our opinion the Colliery Managers' Examinations are open to much improvement for various reasons, which we will discuss herewith.

Under existing arrangements there are twelve distinct Examination Boards, each vested with almost unlimited power regarding the examinations. The outcome of this is that the requirements and standard of qualification are different in each district. For example, the minimum age at which a candidate can obtain a certificate in the first class ranges from 21 to 23 years, and in the second class from 21 to 24. Now if a person is capable of managing a colliery in Durham at the age of 21, is he not also capable of managing one in Staffordshire at the same age? If so, why is the minimum age in the latter district 23 years? Again, if a person should be 23 years of age before he is capable of performing the necessary duties of a colliery manager (and we are not disputing this), then without doubt a person under that age is, in the majority of cases at least, insufficiently experienced, and we arrive at the conclusion that a candidate at 21 is incapable of performing his duties. There can be only one justifiable age at which a candidate should be eligible for a certificate. If this age is 21, then candidates in South Staffordshire, etc., are suffering an injustice by being deprived of a good position for two years. It is evident that the gentlemen of those boards which limit the age to 23 years are of opinion that certificates of proficiency should not be granted to persons under this age, yet a person at the age of 21, can, if his means so allow, leave one of these districts for a few days and obtain a certificate in another district, and can return and take up a position as a colliery manager in the district where the age is restricted to 23, and be recognised as fully qualified. It is indeed a poor arrangement which renders such an artifice, if so it may be called, necessary.

Another point which we wish to refer to is the comparison of the minimum ages for first and second class certificates in the South Wales district. A candidate may obtain a first-class certificate at the age of 21, while a candidate for the second-class must be 24. Granting that an under-manager's duties of controlling the workmen renders the minimum age of 23 necessary, and that a young man aged 21 is sufficiently competent to manage a colliery as his duties do not include the general control of the workmen, then to secure the advantage for which the ages have been thus arranged (if the above be the reason, and we can think of nó other) it is necessary to prevent first-class certificated men from taking the position of under-manager unless they are of the age required for second-class certificates. But this is not done, thereby preventing a working-man whose elementary education does not permit him to obtain a first-class certificate, from becoming an under-manager till the age of 24.

Now, with regard to the five years' practical experience which a candidate is required to have by the Act previous to his obtaining a certificate. In some districts, applicants are eligible for examination who have been for the specified time apprenticed to a mining engineer, providing the apprentice has, in the discharge of his duties, regularly to go down the mine and obtain practical experience therein, while in other districts an applicant is not eligible unless he has acted as an undergronnd official for a period of not less than two years. It is needless to say much on the above, except that such divergent interpretations of the Act are deplorable.

We next come to the subjects of examinations. Here again we have a widely divergent programme: some boards include besides the general mining subjects, surveying and ambulance work, whilst in others one or both of these subjects are disregarded.

Considerable annoyance has been caused by the non-publication of the examination papers in the majority of cases. In our opinion, examination papers should not be published. As one writer happily remarks: "A colliery manager should be almost omniscient in his own province." Then wherefore the publication of questions; since the subjects of examinations are stated in detail what more is required by the proficient candidate. The exposure of the questions simply allows an incapable candidate to learn up some pet questions, and thereby succeed in gaining authority to occupy a position for which he may be totally unfit. The examinations are intended to test an applicant's capability of managing a colliery, and not his efficiency for answering definite questions. At the same time, with the existing arrangements of numerous distinct boards, we believe that the publication of the questions generally would tend to good results in one direction at least. It would enable the boards to arrive at a somewhat definite standard of qualifications. But this is doubtful since a definite age is not maintained throughout, although the ages required by each board are known to all.

Table showing Minimum Ages and Standard of Qualifications, judged roughly from the percentage of passes.

District.	Age 1st Class.	Age 2nd Class.	Candidates 1st Class, 1893.	Passed 1st Class, 1893.	Candidates 2nd Class, 1893.	Passed 2nd Class, 1893.
Scotland, east	22	22	53	32	47	44
Scotland, west	23	23	51	17	40	23
Newcastle	22	22	20	8	60	28
Durham	21	21	9	5	47	20
Yorkshire and Lincolnshire	23	23	34	24	84	46
Manchester and Ireland	21	21	74	18	97	26
Liverpool	22	22	—	—	—	—
Midland	23	23	16	9	41	25
Staffordshire, north	22	22	8	2	14	10
Staffordshire, south	23	23	7	3	12	8
South Western	21	21	17	2	39	24
South Wales	21	24	—	—	—	—

We have shown conclusively by the foregoing, to our own satisfaction at least, that the details of the examinations as now conducted are wrong in principle, but it is an easy thing to criticise something which is wrong, compared with making it right. We can, however, give a humble suggestion, and depend upon mightier minds to develope and improve on it. If our efforts are successful in attracting the attention of those who can effect the change we will consider ourselves repaid.

In the first place we advocate the adoption of one central board of examination, the committee to consist of the Government mining inspectors, together with 12 colliery owners, 12 unbiassed mining gentlemen, and 12 workmen's representatives chosen from the various districts. This would form a total of 48 persons who would settle definitely the minimum ages, the requirements, and the details of the subjects of examination necessary for each class, and also appoint a number of capable mining authorities as examiners. The examinations to take place once or twice a year at, say, six different centres, the examination paper for each centre being the same, and all to be examined by one set of examiners. The whole of the papers to be given out on the same day, and the examination at each centre to be under the charge of a local secretary or custodian, as is done with other examinations. Those candidates who obtained the percentage of marks limited by the committee to be called up for *viva voce* a few days after the written examination. The *viva voce* for each centre to be on a different day to allow the examiners to attend each. In lieu of the above, one centre for examination would perhaps be preferable, and would facilate matters greatly, besides enabling the examination to be conducted with greater satisfaction. The drawback to this arrangement is that many candidates would require to travel a great distance to the examination centre, but this again could be somewhat alleviated by having the centre for the first half-yearly examination in the south of the country and the second in the north.

We would also advise that the time allowed for answering the written paper be increased. In actual practice a colliery manager is not called upon to lay out a colliery or calculate the machinery required in half-an-hour, and we see no reason why a candidate should be required to do so at the examination.

Our suggestions may not stand the strictest investigation in every detail, but in the main we think it would at least answer better than present arrangements. If two heads are better than one, then a committee of 48 should be capable of arriving at some more suitable method of conducting the examinations than 12 distinct boards of 10 members each.

The Editor.

We are pleased to state we have received permission from the *Colliery Engineer and Metal Miner*, Scranton, Pa., U.S.A., to reproduce a series of Articles, entitled :

MINE VENTILATION MADE EASY,

BY

WM. FAIRLEY, Ph.D., F.G.S.,
Mining Engineer;

and also permission from the Proprietors of the *Colliery Managers' Pocket Book*, to produce a map showing the British Coalfields and Inspectors' Districts, etc. The importance and worth of these acquisitions will be fully recognised by the reader, and we shall endeavour to take advantage of them as soon as possible.

VENTILATION.

With references to incidents from personal experience
By JOSEPH CARTER.

Dangerous Gases met with in Coal Mines.

The principal gases met with in mines are the following:—

1.—Carbonic Acid CO_2 sometimes called stythe, choke-damp or black-damp. Its correct name is Carbon Dioxide, specific gravity 1·529. It is a colourless gas, does not support combustion and is incombustible. The effect of this gas is the same as a rope tightly drawn round the throat, owing to its action depriving the lungs of oxygen. CO_2 is sometimes met with especially in shallow mines which are rather damp, and on account of its weight it tends to accumulate in the lowest places and is consequently found near the floor. The deadly "choke-damp" which is formed after an explosion of "fire-damp" in a coal mine consists to a large extent of CO_2. This gas is not only given off naturally in many mines but is always found to result from the breathing of men and animals, burning of candles and lamps, and mixed with other gases from the explosion of the powders used in blasting; it is dangerous to life to breathe air containing 8 per cent. of this gas. Its chemical composition is Oxygen, 72·73 % by weight; Carbon, 27·27 % by weight.

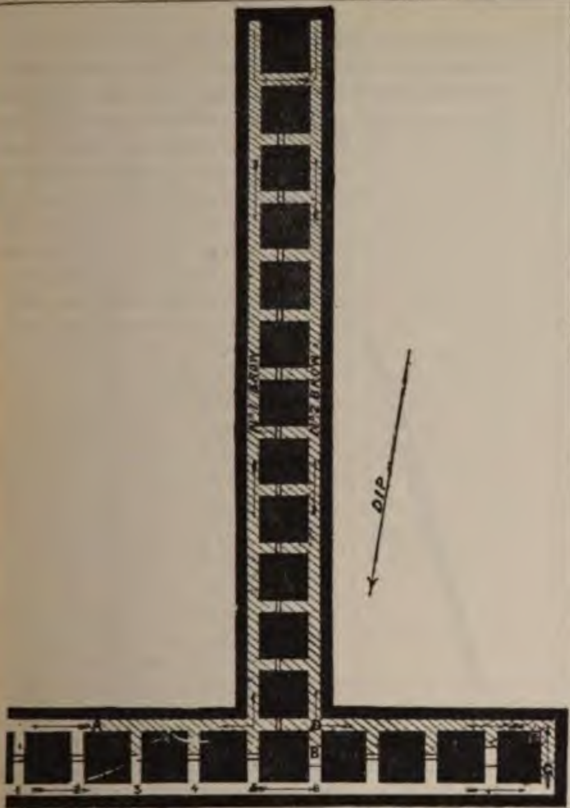
2.—Carbonic Oxide CO or Carbon Monoxide also known as White-damp.

Chemical composition 56·69% by weight of oxygen; 43·31% by weight of carbon; specific gravity, ·975. This gas does not support the combustion of other bodies but is itself an inflammable gas; it has no taste but its odour is peculiar. The effect of this gas is much more deadly than carbonic acid, the breathing of air containing 1% producing fatal results. This gas is seldom found in coal mines except as the result of the explosion of gunpowder, or the combustion of coal or wood, and a certain proportion of it might be mixed with air so as to form a mixture in which lamps or candles would burn while life would become extinct.

3.—Hydro-Sulphuric Acid H_2S or Sulphuretted Hydrogen.—This gas is sometimes met with in coal mines and has a very unpleasant smell which resembles that of rotten eggs. It is colourless, does not support combustion, but is itself inflammable and burns when ignited in a supply of air. When inhaled in its pure state it acts as a narcotic poison. Composition, 94·15% by weight of sulphur; 5·85% hydrogen; specific gravity, 1·174. It is probably formed to some extent when pyrites are undergoing decomposition, and a certain proportion of this gas when present in the air of mines, may, if it is not detected by its odour prove fatal to life before its presence is detected, because candles or lamps will burn in such a mixture. This gas is frequently found in old unventilated workings partly filled with water.

4.—Light Carburetted Hydrogen CH_4 or Methylic Hydride, commonly known as fire-damp, marsh gas, fire or gas. Composition, 24·6% by weight of hydrogen; 75·4% carbon; specific gravity, ·569. Owing to its lightness it is found near the roof or the highest parts of the mines, breaks or crevices in the roof being often receptacles for this gas, besides being given off naturally in our mines from the pores of the coal and metals; it is more frequently met with in coal mines than any other, and at various times has played a very conspicuous part in many of our great mining disasters, which have from time to time occurred, viz.: The dreaded explosion of a colliery with its direful results as has been seen and witnessed by many of those who have had a considerable experience in mines—besides being given off naturally in mines; and at times great blowers and outbursts of this gas have been known to issue forth without any due warning, though no doubt many accidents have been caused by lights from explosives and even naked lights or improper lamps coming in contact with it at the time. As I have had considerable experience in fiery mines, I think it will not be out of place here to show the position of workings where large accumulations of gas have been found, the cause of same, and the method adopted for its safe removal.

The accompanying sketch shows the position of a portion of the mine in which my first experience of a large body of gas occurred. The sketch shows a pair of brows 360 yards up, openings cut through every 30 yards; the brows were 10 feet wide and the openings 7 feet (these brows were in cutting to prove some coal to the rise) each opening had a brick stopping in for the guidance of ventilation except the top opening. In brow No. 2, we had an outburst of gas near the face (so we discovered after the removal of the gas); this outburst occurred sometime



(Shaded portion of roads shows locality of gas.)

between Sunday morning and Monday morning, at a time when there was only the furnaceman at work, but as the brows were over 1,000 yards away from the shaft, the presence of the gas was not discovered until the fireman went to make his usual inspection before the men descended the mine; to his surprise he found fire-damp first at the point C, then at B, and also came across the gas on examining in the return at A; as this mine was not considered to be fiery, we came to the conclusion that there must have been an outburst of gas of considerable magnitude; of course this was reported and communicated to the manager whom I was assisting at the time we went to make an examination of the same and to give instructions as to its removal.

The following important arrangements were made before commencing to remove the gas:—

1st—All men were sent out of the mine except those actually engaged in the work and superintending the same.

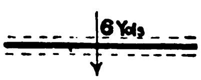
2nd—We selected three of our men who were steady and intelligent.

3rd—All orders and instructions were to be given by the manager and strictly observed.

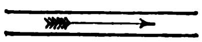
The work then commenced and proceeded as follows:—In the cut through marked No. 2, we put in a pair of regulating doors between the two levels, for the purpose of enabling us to place a man at A to watch the return to see that the gas was diluted as it left this point. The regulators in the doors enabled us to allow a supply of fresh air to pass through for the purpose, because in dealing with large quantities of gas it is always better to dilute and render it harmless before it travels far, which we did with ease and safety. The next step we took was to make a hole through the brick stopping in cut through No. 3, and turn our ventilation through here so as to clear the gas as we proceeded; after this was done we made a hole through the stopping in No. 4 making up the one in No. 3 and turned the ventilation through here and removed the gas to the point beyond the top of the opening, and so proceeded until we arrived at point D. Our next step was to clear the place above C, which was easily done after we had broken a hole through stopping in the higher level between the two brows. We next commenced at point D, and this in reality was the commencement of the work as we had now the whole body of gas before us. We then commenced to brattice from D, putting up a little at a time and taking care to remove the gas steadily and not too quickly; during this time the man placed at A was carefully testing the return to see that the gas was diluted before it left that point, and the manager moved from one point to the other to see how things were progressing and to see that the men were working according to instructions. We proceeded with the clothing steadily until we reached the next opening; we then made a hole through the brick stopping in this opening and closed the stopping in opening below, and in this manner proceeded until we arrived at the top of brow which we did in safety; when we were near the face of brow No. 2, we found that there had been an outburst of gas because there was a large blower near the face which we could hear a considerable distance off, and this continued for some months during which time the brows were stopped owing to the gas being giving off. Here it showed that there had been a sudden outburst of gas, because a portion of the roof had burst down about 6 feet in length, and in the centre 3 feet of a cavity. Had this occurred during working hours no doubt a fearful disaster would have been the result.

direction of the air-current may be seen at a glance. The main haulage roads may also be shown by a thick red dash-and-dot line along the centre of the roads. The following details should also be put on the plan :—True north point, magnetic meridian (dated), scale, section of seam, contour lines or lines of equal height—the bottom of the seam at the lowest pit being taken as a datum line, and contour lines shown for every ten yards or less difference in level. The various important accessories for ventilation should also be shown.

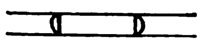
Manner of showing various details on plan :—



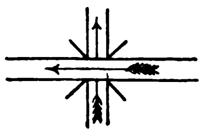
FAULT.—Firm line in red, dotted lines in black, showing allowance to be made for bad coal. Arrow shows direction of throw.



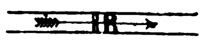
DIRECTION OF AIR CURRENT.—Arrow in red.



DOORS.—The word "doors" might be printed above.



AIRCROSSING.—The word "aircrossing" might be printed above.



REGULATOR.–The same applies to this.

MAGNETIC MERIDIAN.

Contour lines above datum line in red, below datum line in blue.—ED.

Question 6.—What are the special advantages and disadvantages of steam pumping engines placed underground?

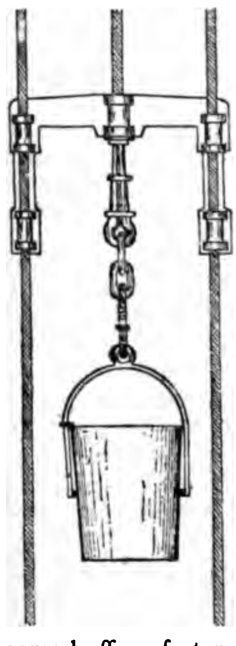
Answer.—The advantages are :—(1) There is nothing more consistent with judicial economy than having engines near their work; (2) consequently a smaller engine is required. (3) There are no heavy rods to lift, for these are dispensed with. (4) Less room is required in the shaft and the space can be utilised for other purposes. (5) The work of the engine is not so heavy. (6) Less cost in outlay. The disadvantages are :—(1) The use of steam underground has a deteriorating effect upon the roof and sides. (2) Owing to the steam having to be conveyed from the surface there is a considerable loss caused through leaking joints and condensation. (3) Owing to the engine being placed underground, there is a possibility of it being lost or drowned out owing to a breakdown of the pump or a sudden intermission of a large feeder of water—if there is not sufficient standage prepared for such emergencies.

JOHN THOMPSON.

FIRST-CLASS.

Question 7.—Describe, with suitable sketch, how you would arrange to guide the hoppit in a deep sinking shaft.

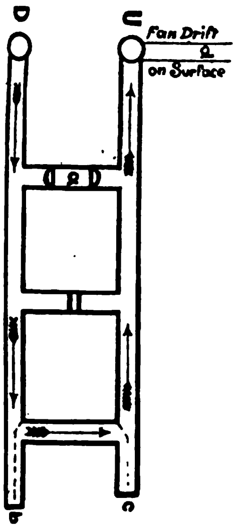
Answer.—The accompanying sketch shows how I would arrange to guide the hoppit in a deep sinking shaft by Mr. Galloway's patent guides. The arrangement consists of two wire-rope guides connected at their lower ends to the walling scaffold, and passing up the shaft over two pulleys on the head-gear to drums worked by a steam crab, each drum being made to work independently, if required, thus providing for any irregularity in the length of the guides. An iron frame, consisting of two legs joined together by a cross-bar, called the 'rider,' clasps the guides at four joints, thus preventing any chance of cross-binding. The winding rope is passed through a hole in the centre of the rider, and the capping, which is used to connect the chain and winding rope together, from the kettle, is provided with a lifter or buffer, made of alternate rings of sheet-iron and india-rubber. When the kettle is lowered, the rider is arrested by some buffers, fastened either on the guides or on the top of the patent scaffold, a number of feet above the bricking scaffold; the kettle continues its descent through a hole in the latter to the bottom, and when it again ascends it comes in contact with the rider, which guides it up the shaft.



JOHN MCPHAIL.

Question 8.—If a water gauge is placed on the separation doors at the bottom of a pit ventilated by fan, will it read more or less than one placed in the fan drift, and why?

Answer.—The water gauge on the separation doors would read less than one in the fan drift, owing to the fact that it measures the resistance of airways, therefore, when we shorten the length of airway connected with the water gauge the readings will be less. The water gauge measures the resistance of the airways on the inbye side of the place where it is fixed, or in other words it reads the difference between two pressures, namely, the intake and return. The pressure measure is equal to the resistance and is recorded in inches and parts of inches of water gauge, which may be converted into lbs. per sq. foot by multiplying by 5·2. To prove the above assertion we will refer to the annexed figure. Supposing a water gauge is fixed to the separation doors as at A, it will measure the resistance which the air current comes in contact with, as it travels from the point A around by B and C and back to A again. But should a water gauge be fixed in the fan drift as at D, it will record the whole resistance, which is produced by the rubbing surfaces of the airways, commencing at the downcast and terminating at the fan drift. The water gauge is sometimes termed an air current pressure gauge, and it may be stated that it measures two conditions. First, the pressure that sets the air in motion; and second, the frictional resistance in the path of the air current—hence the pressure is always equal to the resistance, and the resistance is always equal to the pressure. Therefore the water gauge does not show the shaft resistance when used in a mine.



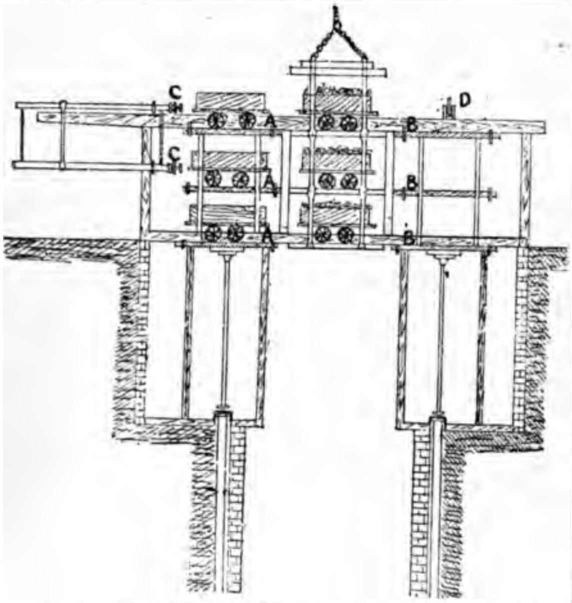
MYLES BROWN.

Question 9.—Is it necessary to maintain the ventilation of a mine when the pit is not working? Give reasons for reply.

Answer.—Yes, it is necessary and highly essential to maintain the ventilation of a mine when the pit is not working, as the chief conditions which require that the ventilation should be maintained are not removed or disannulled by the pit not working. In the C.M.R.A., Section 49, General Rule 1, it is stated that an adequate amount of ventilation shall be constantly produced in every mine to dilute and render harmless noxious gases to such an extent that all places shall be in a fit state for working and passing therein. Hence it is highly necessary to maintain the ventilation of a mine constantly, to comply with the C.M.R.A. It is also necessary to maintain the ventilation of mines both from an economical and safe working standpoint. The state of a mine, after suspension of the ventilation will be of a dangerous and unworkable condition. The chief producers of impure air and noxious gases are still at work when the pit is not working. The only sources which are prevented are those of the breathing of large numbers of men, the fumes given off by the workmen's lamps and explosives used in the mine. Yet the main source is still at work, namely, the emitting of gases from the strata, goaves, &c. Thus, regarding the foregoing reasons, it may be stated that to suspend the ventilation of any mine, only because the pit is not working, would be a foolhardy act, as it would render the safe working of a mine more difficult—the safety of those concerned being the most important item. To suspend the ventilation of any mine would incur expense, owing to the increased necessity of proper examinations for detecting noxious gases and for the removal of the same. MYLES BROWN.

Question 10.—Describe, with sketches, a method of automatically exchanging the tubs in the cage at the surface.

Answer.—Fowler's apparatus is used for simultaneously changing all the decks of the cage. At the platforms on AAA are empty tubs, and at BBB the platforms are ready to receive the full tubs. The tubs on the lower platform are pushed off by manual labour; simultaneously with this, the empty tubs on the two upper decks are thrust forward by hydraulic rams EE and displace the loaded ones on the cage. The catches for retaining the empty tubs are then put into position by a rod and the cage is ready to proceed on its downward journey. The time occupied in



changing being exactly the same as if only one deck was in use. The two platforms A and B are then allowed to sink by hoists, A is ready to receive empties—its decks being successively brought to bank level, and B having been allowed by similar means to bring its middle deck to the bank level, can be further removed so as to take out its uppermost tub. As soon as this is done, counterbalance weights D bring it back into position to receive the full tubs again. Time is saved in changing the tubs on the cage, because the operations of taking the full tubs and putting empty ones in their place is performed while the wind is taking place. Six tubs have been changed on three decks in ten seconds where this apparatus has been tried. (See sketch). JAMES JACKSON.

ANSWERS TO CORRESPONDENTS.

Correspondents during the last few issues must take it for granted that their letters have been received, as they are too numerous to acknowledge individually here.

J. H. S.—Only too pleased to have helped you. Sorry we could not do more. Our endeavour is to further the interest of mining students.

J. S.—Not more than two essays for the session.

J. B., &c.—We have missed an important item out of the conditions of competency for the various awards and certificates, namely—the stage for which a candidate holds a second-class or under-managers certificate was eligible; this has created complications, and several competitors holding this certificate have entered for the Advanced Stage of our competitions. Now, in our opinion, the second-class certificate should be taken as equivalent to a First Advanced Science and Art Department, and the competitors should go one higher and enter for the First-class Stage. Therefore, the competitors holding a Second-class Certificate must answer in the First-class Stage, the answers sent up to the present however, will receive percentage as if they had answered that stage, so that they may not suffer by the misunderstanding.

M. J. A.—Thanks for your suggestion. We think it would however be unfair for the other two stages if we adopted it.

J. H.—You have evidently not taken into consideration that the number of essays to be sent during the session is limited to two. We will most certainly keep "Mining" up to its present standard—we may even surprise you in the near future, by going one better.

J. F. –Send on article. We presume you intend it for an essay in the competition.

C. DYSON.—Will try and oblige you next issue.

INTRODUCTION TO VOL. III.

WE are now celebrating the anniversary of our birthday, the present number being the first of a new volume, and it is with redoubled confidence in our ability to please our readers that we enter into it. "Mining" has now been under the existing manager about eighteen months, and the reception it has received since that time has been beyond our expectations. Our readers we are pleased to say are interesting themselves in the advancement of our little journal, and the ever increasing circulation is sufficient evidence to show the success which attends their efforts, for we are perfectly aware, that no matter how good we may make our paper, it depends upon its existing readers to make it better known.

Newsagents have only awakened to the fact that "Mining" is a fixture which is firmly established in almost all the mining districts of the United Kingdom; it is the only surviving penny mining educator, which shows clearly that we have been successful where others have failed.

Our new departure in the Competition Questions has proved an unexampled success, and although we expected that a great many would take advantage of our offer, yet we were not prepared for the large number of competitors that have entered. The extra work entailed in criticising the questions, giving the marks and choosing the best answers is more than our readers would imagine, and we wish to ask competitors to help us as much as possible by sending in their papers in accordance with the instructions given.

Our efforts to please our subscribers in the past by publishing useful and instructive articles have most certainly been appreciated, but we are making additional arrangements for the present volume, by which we hope to eclipse all former issues in point of merit, and to maintain our journal as the cheapest and best educator published.

We were, as a matter of fact, conceited enough to imagine our paper has been of great benefit to our readers, but the numerous letters recently received tend to show us that it has done more good than even we had reason to expect. A goodly number of our readers have gained certificates of first or second-class competency at this year's Examinations for Colliery Managers, and many of them attribute their success to the reading of "Mining." It has also been the means of inducing men to study for certificates, who, previous to seeing it, had no such intention. We have, without doubt, in many ways done commendable work, and to continue to do so is the ambition and greatest wish of—THE EDITOR.

Printed and Published by STROWGER AND SON, Clarence Yard, Wallgate, Wigan; also Published by JESSE SALISBURY, 48, Fleet Lane, Farringdon Street, London, E.C., and JOHN HEYWOOD, Manchester.

MINING

A JOURNAL DEVOTED TO THE INTERESTS OF MINING

Vol. III. SATURDAY, DECEMBER 15, 1894. FORTNIGHTLY. ONE PENNY.

CONTENTS

Y LESSONS ON MINE SURVEYING

For Beginners.

Commenced in No. 2, Volume II.

—

IMPROVED INSTRUMENTS.

DIALS.

recent years it has become generally acknowledged that the old form of ley dial is not sufficiently accurate for eying modern mines, and as Theodolite's not yet come into favour in this country eneral use in mines, on account of the ulty experienced in manipulating the ument in thin seams, numerous improvets have been made in the miners' dial, h renders it possible to make surveys rground accurate enough for almost all tical purposes.

ean's miners' dial is shown in fig. 86; special feature of this instrument is that dial sights may be detached and replaced vertical arc surmounted by a telescope aking vertical angles in important work.

ig. 87 represents an improved form of the ley dial by Messrs. DAVIS AND SON, h will be found to fulfil all ordinary irements. The special features of this

Fig. 86.

instrument are an outside vernier similar to a Theodolite, an improved form of arc for taking vertical angles, and the sights are interchangeable with a telescope for more accurate work. The advantage of the outside vernier is that the reading is more easily obtained being in a more accessible position. The arc of the ordinary dial is replaced by a circular box $1\frac{3}{4}$ inch diameter, with a dial plate graduated to degrees and traversed by a hand.

THE THEODOLITE.

The Theodolite is essentially an improved dial consisting of almost the same arrangements, but with additional screws for

fine adjustment and reading. For loose-needle surveying it is not so convenient as the dial, but for angling in important positions, especially on the surface where it can be manipulated easily, the Theodolite is by far the better instrument.

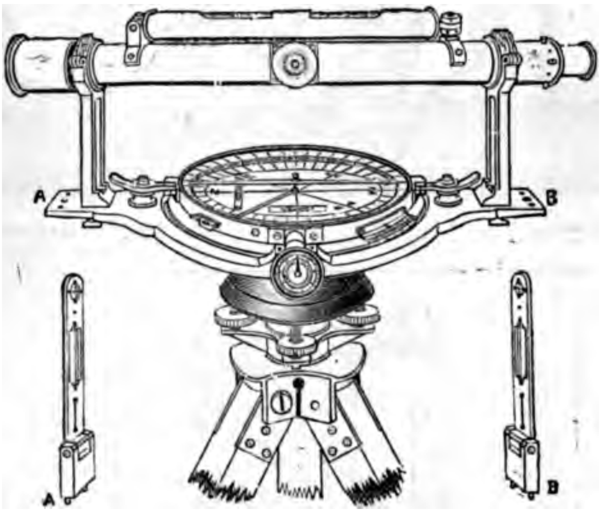


Fig. 87.

There are various forms of Theodolites, but they differ in detail only, the general construction of each being the same. Fig. 88 represents Hoskold's miners' Theodolite. It consists of two horizontal plates (A), the lower one of which is graduated into degrees consecutively from 0 to 360, and the upper one is the vernier plate. The vernier plate may be rotated round the graduated plate and the angle can be read off with the vernier. On the centre of the vernier plate is the compass box (B), the circle of which is also graduated for magnetic bearings. Above the horizontal plates is fitted a telescope (C) which is capable of moving on a horizontal axis, and at the side of which is fitted a vertical graduated circle (D) for reading vertical angles, the index for it is also provided with a vernier. Two levels (E and F) are fitted on the lower portion of the instrument at right angles to each other for adjusting, and another (G) is placed near the top of the instrument for the more accurate adjustment of the telescope when required for vertical angles. In some instruments this latter level is fitted to the top of the telescope and is of rather large size.

The verniers of both the vertical and horizontal graduated circles are provided with microscopes (H and I) for the more accurate reading of same.

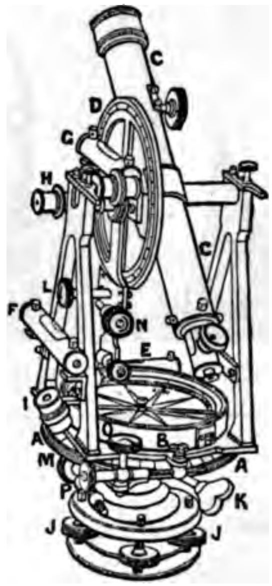


Fig. 88.

To take a sight with the instrument it is first levelled with the four screws (J J) joining the parallel plates, between which is the ball and socket joint on the lower part of the figure. The instrument is now turned until the telescope is *approximately* in the line of sight, and is clamped on the vertical axis above the parallel plate by a thumb screw (K); another screw (L) on the upper portion of the instrument clamps the telescope. The telescope can now be correctly adjusted to the line of sight by a slow motion or tangent screw (M) fitted below the horizontal plates. If the vertical angle is also required, the horizontal cross-wire of the telescope must be made to cut the sight object by means of another slow motion screw (N) fitted near the telescope clamping screw. The instrument is now adjusted to the line of sight and the vertical angle may be read off. Should the angle which another line makes with this base line be required, then the position of the index of the vernier plate should be at 0° previous to the first adjustment, and the clamping screw (O) which holds it in this position should be released in order to adjust the instrument to the second line of sight. The graduated horizontal plate is retained stationary, but the vernier plate together with the telescope, &c., may be turned to the second line of sight. When approximately adjusted the horizontal plates are again clamped by the screw (O), and the more correct adjustment made with another slow

motion screw (P). The angle which the vernier plate has passed through may then be read off by the vernier as in ordinary fast-needle surveying.

The manipulating screws of the Theodolite may be divided into three sets:—1st, the clamping screw (L) and the slow motion screw (N) which adjusts the telescope; 2nd, similar screws (O and P) for adjusting the vernier plate in a relative position with the horizontal graduated plate when taking a sight; and 3rd, similar screws (K and M) for adjusting the whole of the instrument horizontally on the vertical axis above the ball and socket joint to a line of sight.

In some Theodolites two verniers, 180° apart, that is in a straight line with the centre of the circle, are provided for the readings of both the horizontal and vertical angles, to test the construction of the instrument, and if the two verniers give slightly different readings, the mean of the two are taken.

(To be continued.)

EDITORIAL CHAT.

We have some important and useful information which we are desirous of publishing, but have been prevented from so doing through lack of space, and as we have recently received more important matter we purpose publishing next issue, instead of the ordinary number, a special enlarged one, the price of which will be Twopence. It will contain in addition to the usual current matter a large Map of the British Coalfield's and Inspectors' Districts (9in. x 6in.), with an abbreviated description of the British Coalfields. Also the first instalment of a series of articles, entitled, "Mine Ventilation made Easy," by W. Fairley, Ph.D., F.G.S., M.E., together with Sundry Information for Candidates for Certificates, &c. The additions will be well worth the extra charge and we hope the venture will meet with the general approval of our readers.

As we have received a considerable amount of correspondence with reference to the nature of the essays for the competitions it is essential that we give some general idea of what is required. We have received from one competitor the geological description of a coalfield, and although he has undoubtedly taken great pains and spent a considerable time over it, yet it does not effect what was intended by us. We wished the essays to be written so that we might judge the ability of a competitor from them, as it can be better shown in an essay than in the answers to questions; but we are aware that such an essay as we have received from this competitor could not be written without constant reference to a book and this is not what we require. Let a student choose some subject with which he is thoroughly acquainted, the more practical the better, and write it out in his own words. If some coalfield be chosen, let the description deal more with the methods of working and less with the geological tables.—EDITOR.

COMPETITION QUESTIONS.

No. 5 SET.

To the sender of the best set of Original Answers in each Stage will be awarded the following:—

Elementary 2s. 6d., Advanced 3s. 6d., First-Class 4s. 6d.

A Competitor may only answer one Stage in each issue, though a different Stage may be taken in another issue. The best answer to each question will be published with the sender's name and address.

1.—All envelopes must be marked "COMPETITION."
2.—To be written on separate sheets of paper with name attached, and on one side of the paper only. Sketches to be in ink on *unruled* paper.
3.—Correct name and postal address must be sent.
4.—They must reach us by December 28th, 1894.
5.—The Editor's decision as to winners to be final.

ELEMENTARY.

Question 1.—Give a detailed account, with sketches, of the ordinary method of boring with rigid rods.

ADVANCED.

Question 2.—Describe with sketch how you would lay out a pit bottom for an output of 600 tons a day?

Question 3.—How would you test for the gases met with in coal mines, and where would you expect to find them?

FIRST-CLASS.

Question 4.—Describe with suitable sketch Galloway's patent bricking scaffold, and state its advantages.

Question 5.—What are the principal causes of accidents in mines, and what would you do to minimise them?

(Answers to above will appear in No. 5.)

NOTE.—We are obliged to remind Competitors that answers copied directly from other works are not satisfactory, and a student who does this, without stating from whence the answer is taken, will be disqualified, and shall not receive a certificate.

IMPORTANT NOTICE.

The next issue of this journal (No. 3) will be

AN ENLARGED SPECIAL NUMBER,

with Map of the British Coalfields, &c., &c.

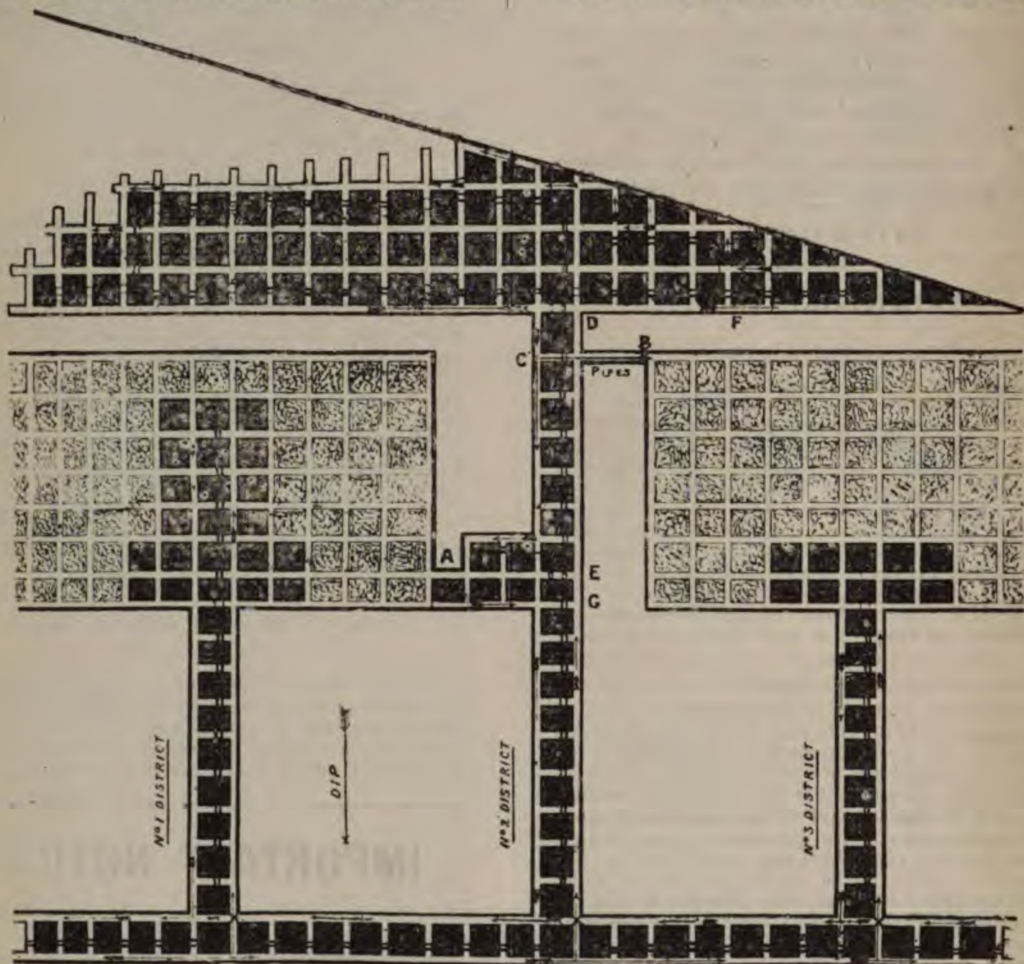
PRICE TWOPENCE.

VENTILATION.

With references to incidents from personal experiences
By JOSEPH CARTER, First Class Certificated Manager.

Accumulations of Gas, and how to deal with them?

THE accompanying sketch shows a portion of the workings of a mine of which I had charge some few years ago, and in which I had to contend with numerous difficulties occasioned by large accumulations of gas (CH_4). Gas was given off in No. 2 district at the points A B from old goaves, by the atmospheric pressure, consequently gas issued freely during a fall in the barometer. The outlet B for the gas from the No. 3 district being on the higher side allowed the gas to drain off as it was given out. This difficulty arose while negotiations were pending for an exchange of coal on the higher side; but the delay was so long that the Nos. 1 and 3 districts were driven to their original boundary, and so as not to decrease the output a large number of the pillars were worked, but No. 1 portion had to be stopped pending arrangements, which were delayed so long, that this part became entirely blocked up, so that ventilation could not be carried



but under different conditions. The outlet A for the gas from the goaf of the No. 1 district being on the lower side, the whole of the goaf above this point served as a reservoir for the gas which was retained in compression through the greater portion of it. No. 3 district was also cut to the original boundary and then brought back a good distance, the result being as shown in sketch—a large goaf on each side of No. 2 district,

which on several occasions caused a great amount of trouble.

At A, which was the point of communication with the goaf, CH_4 was at all times given off, but when a gradual lowering of atmospheric pressure was going on, this gas would gradually expand and could be found several yards nearer than A, even before a visable change in the barometer was noticed, owing to gas being more sensitive than mercury. We had however sufficient air to cope with it under all ordinary circumstances until a great and sudden fall in the atmospheric pressure took place, when the gas given off from this point was greatly increased; on one occasion I found it had reached to C, and before our ventilation overcame it some portion of the workings above became partially filled; at other times I have observed it travelling near the roof above the ventilating current for a good distance when the ventilation has not been sufficient to cope with it at the time, owing to a sudden depression of the atmosphere. What does this fact teach us? To my mind it shows very clearly that when we have a high barometer we have the greatest danger, because a great and sudden fall of the pressure, at once releases not only the gases which are given off, but gases in the goaves expand so rapidly and issue into the workings so quickly that there is always a very great amount of danger, whereas with a low barometer there is no need to fear a change, because if any, it will be a rise and this will be for the better.

The gas from the goaf at B was then carried directly to the return at C by means of 1½ inch wrought-iron pipes, and diluted as it was given off, even with a gradual or sudden falling of the barometer. This was owing to the point of escape for gas being on the highest part, or nearly so, of the goaf. The reason for such changes as I have named is owing to the fact that all gases are compressible, therefore a sudden fall of the atmospheric pressure results in a sudden expansion of the gases, the result being that the gas expands and comes into the workings of the mine, when the ventilation is only such, that under ordinary circumstances it will keep all free and clear from gas; therefore as these are not ordinary, the result is a large body of gas is given out which overpowers the ventilation and fouls the workings.

The greatest difficulty we had in this district was when the whole of the workings beyond D were filled with gas; this was caused by the workings of the mine below which was only a distance of 23 yards and which was in advance. At this time they were working the pillars out from the same boundary and had proceeded some distance away when timber was taken out of the waste, the roof fell, and caused the whole strata between the two mines to be broken up, the consequence being, that it not only allowed the gas which was made in the lower mine to escape through the breaks, but also liberated the gas in each of the goaves on each side of the district. The fireman, in making his round of inspection on Sunday morning, found it as described, and this was reported to me at once; I went with him to inspect the place and the cause was clearly indicated to us by the weighting and crunching under our feet. The result of this was that this district was stopped for a short time until the gas had been drained from the various sources, so as to enable us to cope with it.

The method which we adopted for the removal of the gas was as follows:—At E we had already a pair of doors which we converted into regulating doors, so that we could dilute the gas before it left this point as we were removing it from the workings above; also at this point we placed a man to attend to this while I kept moving from one point to another to see that my instructions were being carried out. We had two doors in at D which we opened, and the two hangingcloths above D were then opened and put on one side; then from the point D we commenced to brattice, putting up a little at a time so as to remove the gas steadily; it was a tedious task owing to the quantity we had to deal with, and with all such work great care and tact must be used so as to do it with safety, because one reckless step might be the means of a great catastrophe. When we had reached the opening above D, we made a hole through the brick stopping and closed the doors below, then we proceeded with our bratticing from this opening as before until we reached the boundary side point. This being the highest point for all on the right side of brow, all these places were cleared at the same time except near the far end; these were easily cleared afterwards. At the point F, we found where the gas was issuing through crevices in the roof from the old goaf and strata below. After this, we had very little difficulty in clearing the places on the other side, as we had now removed the greater bulk

of gas, so that by the careful regulating of our stoppings and cloths the task was soon accomplished. This part of the district was stopped for some time owing to the working of the pillars in the mine below in too close proximity. We commenced at G and took all coal out before us, but this did not end our difficulties, because the roads above this point became blocked up in a very short time and the consequence was that all the workings above became filled with gas which was always close at hand in front of the workings, and when a sudden depression took place in the atmosphere, I have seen it on more than one occasion back out into the working places. In this district we had a fireman whose sole duty was to travel continually from one place to another, and during each day every man and place was visited frequently; no explosives of any kind were used in the district. There was one thing I observed that by acquainting the men of the dangerous gases near them a greater care on their part was exercised than would have been the case if I had let them keep on working ignorant of the dangers surrounding them. By these means the difficulties were overcome without any accident whatever from gas.

ANSWERS TO CORRESPONDENTS.

RECEIVED.—Colliery Engineer, Technical World, Invention, Universal Index, Electricity; also T. E. Davies, W. D. Harbitt, A. Gourlay.

C.D. (Wakefield).—Exam. in Newcastle District in January. See M. W. Brown, Esq., Neville Hall, Newcastle-on-Tyne. The one in the Yorkshire and Lincolnshire District, in June, would perhaps suit you better if the requirements suit you. Sec. J. R. Jeffery, Esq., 5, Piccadilly, Bradford. We will in all probability give you further information next issue.

S.T.B. (Nuneaton).—Yes, the essays you suggest would be suitable; see Editorial Chat.

T. D. STANT.—Thanks for correction. Will see it is rectified in next issue.

A. HART.—You may get the examination papers set each year by the Science and Art Department in all the subjects, at a charge of 6d. each, post free, from Messrs. Eyre and Spottiswoode, East Harding Street, London, E.C., but the questions for any one subject are not published separately. We will, however, publish the Elementary Questions in Geology for the year 1893 in next issue, which may be sufficient for you.

Literary communications to be addressed to the Editor, "Mining," Clarence Yard, Wallgate, Wigan.

ANSWERS TO QUESTIONS

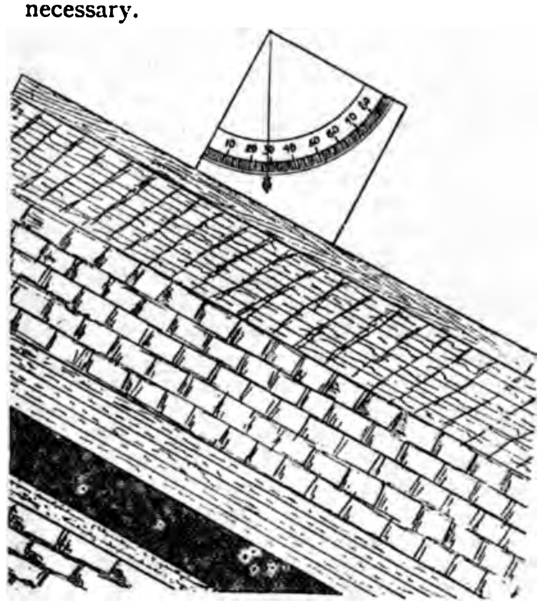
SET No. 11.

In No. 25, Vol. 2.

ELEMENTARY.

PROSPECTING.

Question 1.—Give a detailed account of how you would search for coal in an unknown district. Describe the instruments you would use (if any), to find the probable direction, rate of the dip, etc. Give sketches, if necessary.



Answer.—In the search for coal in an unknown district a valuable amount of knowledge may be obtained by surface researches, unaccompanied by the breaking of the ground. Quarries, protruding rocks, sea cliffs, and water-courses will all yield, to an experienced eye, their quantum of information. Even when the general surface is occupied by a thick cover of clay, gravel, etc., good facts may be gleaned in the channels and banks of the rivers which have cut their way down to the harder rocks. "Shoaling" is a process whereby the beds of rivers are examined for small pieces of a mineral, or rock known to contain that mineral. I would commence at the lowest point of the river and examine the stones as I proceeded up-stream for some indication of coal. The stones at the commencement would be very small, owing to the grinding and wearing action of the water, but would increase in size as I proceeded up-stream until they

would altogether cease. If these stones belonged to the coal measures I would conclude that where they ceased would show the near indication of coal seam. In this kind of search we must learn to avoid being deceived by vain resemblances. It would be a great risk to spend money in sinking operations, no matter how black the shales or the outward resemblance of them to the carboniferous shales, unless we are able to find in them some of the fossils (described in No. 2, Vol. II) proper to the period. The existence of the seam having been ascertained, or at least shown to be highly probable, then I would put down a few bore-holes as near as possible in a direct line, at right angles to the line of strike or in the direction of the dip. These holes I would put closer together in disturbed than in undisturbed districts, as also where the inclination of the rocks is very great. To find the direction and rate of dip, I would use a little instrument, called the "clinometer," which, when combined with a compass, forms a most useful prospecting companion. It is used as follows, a ledge of rock is bared to the bedding line and a straight piece of wood, several feet in length, is placed between the lower edge of the clinometer and the rock, so that the observation may be taken over a considerable distance. The plummet will then show on the graduated arc the inclination in degrees. Several observations must be taken, and that direction which gives the greatest inclination is the direction of the dip, and the magnetic bearing of this line should be taken with the compass.

W. H. HARDY.

ADVANCED.

METEOROLOGICAL INSTRUMENTS.

Question 2.—Describe the principle and use of the thermometer, barometer, anemometer, and water gauge.

THERMOMETER.

Answer.—The thermometer is a measurer of temperature, mercury being used for ordinary temperatures, and it depends for its action on the fact that all bodies with the rise and fall of their temperatures expand and contract. This instrument consists of a glass tube, closed at the top, with a bulb at its bottom end, in which is a quantity of mercury. A scale of degrees is fixed to the tube. As used in mines the thermometer registers the temperature of the air, and we are able to measure the difference of temperature between the air in the downcast and upcast shafts or at any desired point in the workings. Thermometers are graduated according to three scales, viz., Fahrenheit's, which is that commonly used in England; Centigrade, which is generally used in scientific calculations and Reaumur's which is the one used on the continent. On Fahrenheit's thermometer 32 degrees indicate the freezing point, and 212 the boiling point of water, and the space between these two fixed points is divided into 180 equal divisions; these equal divisions are produced above and below 32 degrees and 212 degrees. In the Centigrade thermometer 0 degrees indicate the freezing point and 100 degrees the boiling point of water, the space between these two points being divided into 100 equal divisions.

Barometer and Thermometer combined.

Water Gauge.

Anemometer.

In Reaumur's, 0 degrees indicate the freezing point and 80 degrees the boiling point of water, the space between these two points being divided into 80 equal divisions. It is plain, therefore, that 180 degrees Fah. =

100 Cent. = 80 Reaum., and also 1 degree Fah. = $\frac{5}{9}$ Cent. = $\frac{4}{9}$ Reaum. To transfer Fahrenheit's degrees to the other scales we must first subtract 32 degrees, in order that the number of degrees from the freezing point may be ascertained. These multiplied by $\frac{5}{9}$ths will give the equivalent number of Centigrade, and multiplied by $\frac{4}{9}$ths the equivalent number of degrees Reaumur. To reduce Centigrade and Reaumur degrees to Fahrenheit scale, multiply by $\frac{9}{5}$ and $\frac{9}{4}$ respectively and add 32 degrees. If the temperature is below zero in any of the scales a minus sign (—) is placed before the number, thus: —5 degrees Fah. means 37 degrees below freezing point.

BAROMETER.

The barometer is an instrument used for measuring the pressure of the air. If a glass tube, a yard long and closed at one end, be filled with mercury and inverted with the finger placed over the open end until that end be placed in a vessel containing mercury and then removed, a part of the mercury will run out, but the tube remains filled to a height of about 30 inches above the surface of the mercury in the vessel. That is, the ordinary pressure of the atmosphere is sufficient to balance a column of mercury 30 inches high. But the pressure of the atmosphere varies in this country between 28 and 31 inches of mercury. The barometer has a scale and a sliding vernier fixed to it, by means of which it may be read to the $\frac{1}{100}$ part of an inch. The barometer is of service in showing atmospheric changes. The issue of firedamp from the goaves and working faces of the mines is checked when the barometer is high and liberated rather more freely when the barometer is low. A consideration of the difference of the quantity of gas yielded under the two extremes of the barometer is not so important, however, as the occurrence simultaneous with a falling barometer, because the escape of firedamp is facilitated when, after the barometer has stood steadily at a high or moderately high reading for some days, it is succeeded by a rapid and sudden fall. The gas under these circumstances issues more freely from the coal and owing to the reduced pressure finds its way out of the goaves into the roads. It is important, therefore, to exercise increased vigilance in fiery mines during a falling barometer, whether it stood high or not before it began to fall. Numerous cases are recorded where the airways of mines were found to contain large quantities of firedamp with a steady barometer of long continuance, though the airways were a short time previously clear of the gas at the same indication of the barometer. This has been followed by a falling barometer proving that the firedamp of our mines is more sensitive to atmospheric changes than the barometer, as indeed might be expected, gas being such an attenuated, mobile, and highly elastic fluid. The lesson to be learned from this is, that while we duly appreciate the barometer and go to it continually for its readings, we do not rely solely on it but continue our examinations with extreme caution to the innermost recesses of the mine, ever on the alert for any change.

ANEMOMETER.

The anemometer is an instrument for measuring the velocity of the air. It consists of a hoop within which revolves a wheel carrying vanes. The vanes are so arranged that when the instrument is held at right angles to the direction of the air the vanes will fall obliquely to its path. The force of the air on the vanes causes the wheel to revolve, which works toothed wheels of various diameters, and to their spindles are attached pointers, which indicate by the dial or dials the velocity of the air in feet, units, tens, hundreds, and in some cases more, for the time held in the airway. It is also provided with a catch, so that it can be stopped and started at a set time when measuring. The method of holding the anemometer is worthy of notice, as various results may be obtained in the same airway, owing to the difference in the velocity of the current at different parts of the airway. The anemometer should be held at arms length in front of the body and then moved slowly and uniformly over the whole area from a point near the floor to a point near the roof. Several trials ought to be made in the same place and the average result taken. In large airways and fan drifts, where the greatest accuracy may be required in testing the efficiency of fans, the most correct method is to fix fine wires or strings across the road from side to side and from floor to roof at regular distances apart, the one set of strings being placed at right angles to the other, so as to divide the airway into a number of equal divisions, and then to note the revolutions of the anemometer during one, two, or three minutes at each division. The mean of these are taken, but the operation should be repeated in cases

where great accuracy is desired; and if the mean result differs materially from the first mean result it will be necessary to go through the operation several times.

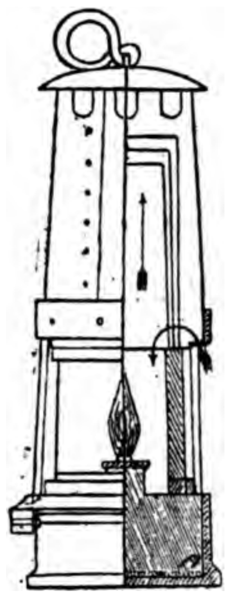
WATER-GAUGE.

The water-gauge is a very simple instrument and consists of a bent tube like the letter U, both ends of the tube being open. A little water is placed in the bend of the tube, which forms the bottom part of it and a sliding scale of inches and decimals of inches is attached to it. At the top of one arm of the tube is placed a nosepiece, by means of which it is passed through a door, and by so doing one side of the tube is placed in contact with the air on one side of the door and the other is exposed to the influence of the atmosphere or air-current at the other side. Where a difference of atmospheric pressure exists, such as would be found between the intake and return currents of air near the shafts or between a fan drift and the outside air on the surface, the water is depressed on one side of the tube and raised in the other. The scale of inches and decimals shows the difference of level in the tubes. The instrument is used thus to show the force of the air-current generated whether by furnace or fan. The weight of a cubic inch of water being ·036lbs. if the water-gauge reads one inch the pressure is ·036lbs. per square inch, or $\cdot036 \times 144 = 5\cdot184$lbs. per square foot, usually taken at 5·2lbs. per square foot. For any other reading of the water-gauge, multiply 5·2lbs. by that reading to find the pressure per square foot. Thus, ·5 on the water-gauge $= \cdot5 \times 5\cdot2 = 2\cdot6$lbs. per square foot. The water-gauge acts as a check on the state of the air-courses, and when they remain in the same state, say, over two days, and the ventilating power is not increased or lessened, the water-gauge on the second day in each position of trial should in ordinary circumstances read the same as on the first day, and if not, it would probably be owing to a all in some air-course which had increased he friction. WM. SUTHERLAND.

THE MARSAUT SAFETY LAMP.

Question 3.—Describe what you consider to be one of the best type of safety lamps.

Answer.—The Marsaut lamp is made with either two or three conical gauzes, and has a thick glass cylinder as in the Clanney lamp. The three gauzes fit close together at their lower extremity and gradually diverge from each other as they proceed upwards. The gauzes are protected by a bonnet of sheet-iron screwed on a flange above the glass. Near the upper end of the bonnet there is a gauze diaphragm containing about 400 apertures to the square inch. Just above this diaphragm, at the top of the bonnet and immediately below the top plate of



the lamp, are a series of holes through which the gases from combustion escape. Near the lower end of the bonnet there are also a number of holes by means of which the feed-air passes through the gauzes immediately above the glass cylinder, and these openings are arranged so as to prevent the direct entry of horizontal currents of air into the lamp. The three gauzes have about 934 holes to the square inch. In all other lamps the mesh of the gauze used is the same as that in the Davy lamp. A flat wick is sometimes used, which gives a better illuminating power than a round one. The lamp goes out in an explosive mixture. When three gauzes are used the lamp is much safer, but the illuminating power is less. The lamp is liable to become much heated, owing to the gases from combustion impugning on the bonnets, which are in good metallic connection with other parts of the lamp. A considerable amount of heat is therefore conducted even to the bottom of the lamp when used where the air-current is not sufficient to keep down the temperature. Other bonnetted lamps become heated in the same way, but no objection can be urged against this so long as very volatile illuminants are used.

WM. SUTHERLAND.

FIRST-CLASS.

FORCE AND EXHAUST FANS.

Question 4.—What are the advantages and disadvantages of a forcing fan ?

Answer.—According to authorities on the subject, the relative efficiency of both fans are comparatively equal, but the exhaust fan

is the one generally adopted in this country. The reason is not far to seek. In primitive methods of ventilation the power —being in most cases heat producers—was applied to the upcast shaft, and when mechanical ventilators were introduced they followed the orthodox method. Another point to be considered is which shaft is to be used for winding purposes, and as the downcast presents various advantages over the upcast in this respect, it is natural that the upcast should be chosen as the fan shaft, for although winding may be effectually conducted in a fan shaft, it is not done with the same facility. Both types of fan create a ventilating current by effecting a difference in pressure in the two shafts; the exhaust fan reduces the pressure at the upcast and the force fan increases the pressure at the downcast: the result of both being practically the same. The force fan has the effect, however, of penning up the gases in the goaves, etc., consequent upon the increased pressure, and this in our opinion is a disadvantage, for should an accident occur to the fan or there be a fall in the barometer there is greater danger to be expected from the gases which will exude from the goaves, by reason of larger accumulations than if an exhaust fan was used. Another advantage of the exhaust fan is that there is not so great a strain upon the machine itself.

EDITOR.

STOPPINGS FOR VENTILATION.

Question 5.—Describe and illustrate how you would put in stoppings, and what material you would use, where the drifts are 15 feet wide and 8 feet high. Show how you would brattice a heading 9 feet wide in the face of which there are large feeders of gas.

Answer.—The construction of stoppings is an important item in connection with the efficient working of a mine. The ordinary method in building stoppings is to build a wall in a straight line from each side of the place, the material consisting of stone or bricks (stone preferable) and lime. After the wall has been built up to the roof it is packed at the return side with refuse, etc., so as to keep it as near airtight as possible. But this method is only applicable to non-fiery and ordinary mines. In the case of extensive and fiery mines I would construct stoppings similar to fig. 1. Each stopping to consist of two walls 15 or 20 feet apart, each with a curved outline, the convex sides of which are built outwards and the space between filled closely with stone and refuse. The constructing of stoppings in a fiery mine should have due consideration; stoppings

Fig. 1.

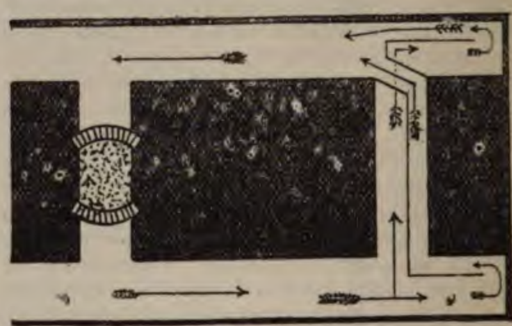


Fig. 2.

well built of stone and cement, or good lime, and in the shape of those in fig. 1, will be found to withstand a severe shock, which may be produced by an explosion. Should the stoppings withstand the shock of an explosion, it is evident that it will be the means of saving life, owing to immediate restoration of the ventilation, which is the main problem to be solved after such a disaster has occurred. Where the drifts are 15 feet wide and 8 feet high, I should construct the stoppings as shown in fig. 1, supposing it to be a fiery and extensive mine; the ordinary single method would be adopted in non-fiery and small mines. In headings giving off large feeders of gas I would ventilate as shown in fig. 2, thus transmitting the foul air from the heading direct to the return, without coming in contact with any more working faces.

MYLES BROWN.

THE PRINCIPLE OF THE SAFETY LAMP.

Question 6.—Explain the principle of a safety lamp, and say whether it is more likely to pass flame through a gauze with a large flame or a small one when it is put into an explosive mixture. Give reasons for your answer.

Answer.—The one important item of the safety lamp is the gauze, which is used to protect and encircle the flame of the lamp. The whole principle of the lamp is centred

in the gauze, which consists of iron or copper wire woven into a circular gauze, containing 784 apertures per square inch. The air which feeds the flame enters at the lower end of the lamp, and the vitiated air passes off near the top. The main feature requisite to the safe working of the lamp is that the gases given off by combustion should be sufficiently cooled on their passage through the gauze so as not to ignite the gases of the outer atmosphere. This feature is produced by the conductivity of the wire used. Hence, the wire employed in the manufacture of the gauzes should be of a high conductive power. Therefore, if we have inflammable gas ignited within the lamp, the heated gases given off by combustion on their passage through the apertures of the gauze are cooled down to such a temperature as will not ignite the gases of the outer atmosphere. By noting the principle of the safety lamp it is evident that a large flame is more likely to pass flame through a gauze than a small one. The proof of the foregoing assertion is found by noting the action of a gauze when in contact with a large flame, which tends to heat the wire until it becomes red hot. At this point the lamp is unsafe in an explosive mixture, as it will transmit heated gases sufficient to ignite and explode the outer gases.

MYLES BROWN.

AWARDS

FOR ANSWERS TO COMPETITION QUESTIONS—No. 2 SET.

ELEMENTARY.—W. H. Hardy, Greenhills, Eastwood, Notts.

Commended.—M. Collinson, T. D. Stuart, R. Turner, W. T. Hewitt, J. Finch, T. Henry, G. Tweedale, R. Cherrie, N. Dunscombe, D. Turner, J. H. Marsh.

ADVANCED.—W. Sutherland, Granville Terrace, Stoney Lane, Hindley.

Commended.—S. Davies, T. E. Aitchison, J. Stephenson, W. Johnson, J. Hardman, J. Jones, J. Graham, J. H. Senior, T. Lawrenson, W. Pace. H. Bradshaw, R. Spence, J. Forster, G. Bell, J. Davies, J. Crone, R. Forster, H. Hall, Hy. Talbot, J. Rhoss, T. Holden, G. Brown, J. Walsh, J. Beswick, R. Kay, R. Chegwin.

FIRST-CLASS.—M. Brown, Butterknowle, Darlington.

Commended—J. Jackson, J. McPhail, E. Kenwright, D. Spence, J. Fox, G. Daykin, J. Wheatcroft, J. Smith, J. Harrison, A. Hart, J. T. Brown, J. H. Sherwin, A. Alderson.

CORRESPONDENCE.

We will publish a reasonable amount of correspondence per issue, but subject to the following conditions:—

To be written on one side of the paper only.
Envelopes to be marked "Correspondence."
Name and address of sender must accompany such correspondence as a sign of good faith, but the writer may assume a *Nom-de-plume* to be published if he so desires.
Correspondence must not be enclosed with Competition Answers.

The Editor will not hold himself responsible for any correspondence, nor will the publishing of it affirm that we hold the same views as the writer.

SURVEYING QUESTIONS.—ANSWERS.

Sir,—In answer to "Improver," the only precaution necessary is not to obtain the bearing for the new road from the old meridian but from a recent one. Having the date of the old meridian the declination could be calculated, obviating the necessity of taking a new meridian. To check the accuracy of sight lines in a road with a bad roof I would have not less than three lines hung so that if one got wrong it would be detected immediately, and I would check them constantly with the dial.—MINING STUDENT.

THE USE OF LAMPS AND SHOT-FIRING.—QUERIES.

Sir,—Will you please insert the following questions in "Mining" to be answered by some of your readers. (1)—Explain and compare the following Sections of General Rule 10:—Sections 3 and 4, connection with opening safety lamps and shot-firing; and explain fully the meaning of "a completely closed chamber." (2)—Has an examiner of a mine, or shotsman, any authority for carrying in his possession (*a*) lucifer matches, (*b*) contrivance for opening a safety lamp, (*c*) firing a shot with naked light in a district where safety lamps are used; is it legal for such practice beyond the lamp station? (3)—If such authority is given, what limits ought there to be for the safety of workmen and of the mine?—MINING PROMOTER.

VENTILATION.—CRITICISM OF COMPETITION QUESTION.

Sir,—While looking through the Answers to Competition Questions of No. 26, Vol. II., I notice what I think to be an error made by Mr. Myles Brown. The question I refer to is in the first-class stage and reads thus:—"If the current in a road 6 feet square is maintained by a pressure of 1 inch W.G., what pressure per square foot will be required to pass the same quantity of air along a road 5 feet square, the roads being the same length?" Although Mr. Brown gets the right answer, namely, 1·728, I fail to see how he gets it in the manner in which he works the question. He first finds the relative pressures, which he asserts to be for 6 feet airway 864, and for the 5 feet airway 500. Now, in my opinion, where the greatest relative pressure is, there also must the greatest W.G. But it is not so in Mr. Brown's answer. To get the proper answer he turns the solution round about and gives his ratio as 125 : 216 writing as though he had said the least airway had the greatest relative pressure, which in the first place he said was not so, as it had the least relative pressure, namely, 500. Now, this is my solution of the question:—(1) Friction is directly as rubbing surface. As there is no length given, the

rubbing surface in the 6 feet airway will be as the perimeter $(6+6+6+6)=24$, and in the 5 feet airway $(5+5+5+5)=20$; thus the friction in the two airways is as $24:20::p$. (2) Friction varies as the squares of the velocities. Velocity is inversely as the areas of airways when the same quantity passes through each. Consequently, for the larger airway, 6 feet square, $V=25$, and for the lesser airway, 5 feet × 5 feet, $V=36$. Now, friction varies as the squares of the velocity, thus friction for the 36 feet airway $=25^2$ and for the 25 feet airway $=36^2$

Now as $25^2 : 36^2 ::$ 1in. : W.G. for 5 feet sq. airway.
$24 : 20$

$$=\frac{36\times36\times20\times1}{25\times25\times24}=\frac{36\times6\times1\times1}{25\times5\times1}=\frac{216}{125}=1{\cdot}728 \text{ inches.}$$

Now $1{\cdot}728\times5{\cdot}2=8{\cdot}9856$lbs. pressure per sq. foot.

RALPH ANDERSON.

VENTILATION PROBLEM—ANSWER.

Sir,—In answer to the No. 2 Problem, given by "Perseverance," I beg to submit the following solution:—Shafts 16 feet diameter, upcast 190 yards and downcast 200 yards in depth; airways, four in number, frictional resistance of each being equal to that in an airway 6 feet by 4 feet, and 1,000 yards long. What pressure should the water-gauge show in the upcast when 30,000 cubic feet of air are passing per minute?

$$p=\frac{K\,S\,V^2}{a}$$

p = pressure per square foot.
a = square feet of sectional area.
S = the area of rubbing surface exposed to the current
V = the velocity in thousands of feet per minute.
K = co-efficient of friction, the value of K being equivalent to ·114 feet of air column for every square foot of rubbing surface, and a velocity of a thousand feet per minute.

$p=x$; $K=\cdot114$.
S, of the upcast $=16\times3{\cdot}1416\times190\times3=28{,}651{\cdot}392$ square feet of rubbing surface.
S, of the downcast $=16\times3{\cdot}1416\times200\times3=30{,}159{\cdot}36$ square feet of rubbing surface.
S, of the underground airways $=(12\times8)\times1000\times3\times4=240{,}000$ square feet of rubbing surface.

$$V=\frac{30{,}000}{16\times16\times\cdot7854}=\cdot149 \text{ thousands of feet per min.}$$

Total amount of $S=28{,}651{\cdot}392+30{,}159{\cdot}36+240{,}000=298{,}811$ square feet.

$$p=\frac{K\,S\,V^2}{a}$$

$$p=\frac{\cdot114\times298{,}811\times(\cdot149\times\cdot149)}{201}=3{\cdot}76 \text{ ft. of air col. as pressure required.}$$

Taking the air to have a density due to a temperature of 32° F., and to a pressure of 14·7lbs. per sq. inch, a cubic foot of it would weigh ·0807lbs.

$$\therefore p=3{\cdot}76\times\cdot0807=\cdot303{,}432 \text{ lbs.}$$

$$\text{Water-gauge } \frac{\cdot303{,}432}{5{\cdot}2}=\cdot058 \text{ inches.}$$

The pressure or water-gauge appears extremely small, yet it must be remembered that the quantity is small. But supposing the quantity to be 150,000 cubic feet per min., as is generally the case with modern mines, the water-gauge would be increased as the square of the quantity. Hence

$30{,}000^2 : 150{,}000^2 :: \cdot058 :$ 1½ in. water-gauge.

MYLES BROWN.

COLLIERY MANAGERS' EXAMINATIONS.

The following Letters and Extracts re the above have been received from some of H.M.I.M.

"In view of the probable revision of the law governing Colliery Managers' Examinations it is well the subject should be discussed by all interested.

With some portion of your criticism I quite agree. That the requirements as to age and experience should be uniform throughout the kingdom, the standard of qualification approach uniformity, the recognition of the general application of a certificate to fiery as well as non-fiery mines, and perhaps some approach to reasonable sequence in first and second-class certificates; these main lines should be rigid and uniform.

Personally, I attach great importance to the practical experience. By the Act it is required to be five years in a mine; it is obviously absurd to suppose that five years experience in the screening of coal should qualify to sit for examination as a colliery manager. The proof of the experience should be complete and should be carefully examined. Testimonials and evidence given by employers should be given with care and full recognition of their responsibility, rather than out of goodwill and kindness.

As to the examinations, my experience is distinctly in favour of dividing the written paper—Arithmetic, Mechanics, Act, Practical Working, Gases, and Ventilation. Have a fixed time appointed to each, and collect the answers at the end of each such period. There should be a clear interval for the consideration of the answers by the examiners, then a *viva voce* examination. In this, one would wish to recognise the difficulty some good practical men have in putting their knowledge on paper which no time allowance would meet. One has seen a man pondering hours over one question. The examiners might provide some elasticity to meet this *viva voce*.

As to publication of examination papers. It was right to give the mining community an insight into the character of the examinations that has now been gained; the continued publication of examination papers with the answers, in the wide and varied form one now sees, is open to serious objection.

Much may be said for and against candidates from all parts of the kingdom being eligible to sit in any district, and for and against having one central board of examination."

"I think the present system works well, and there seems to me no need to change it.

The age no doubt should be the same in each district, but that can be put right."

"Each Inspectors' district might remain a centre for examination as at present with an examination once a year. There being twelve inspection districts they could be divided into two groups, say six centres examined in May and six centres examined in December, then there would be one examination in each district every year as at present, and the groups could be arranged so that candidates may always be within easy reach of a centre where an examination would occur within six months."

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CONTENTS.

EASY LESSONS ON MINE SURVEYING

For Beginners.

Commenced in No. 2, Volume II.

PLOTTING THE SURVEY.

THE chief instrument employed for plotting surveys is the protractor. The method of plotting an angle with the protractor has been previously described (No. 5, Vol. II), but a more detailed account of plotting a series of bearings will be given.

As has been previously stated the plan upon which the underground survey is usually plotted has the surface, including the shafts, delineated upon it and also a meridian line. The first survey is then made from the shaft and the plottings commence from this point, subsequent surveys however may be commenced from a known station; if however the survey is to be plotted upon a sheet of paper which does not show the surface or any workings, then a line may be drawn in any suitable position and be adopted as the meridian line from which to plot the survey. The method of procedure now is, if plotting with a brass circular protractor, to apply the feathered edge side of the cross-bar to the meridian line and mark off the centre with a pricker, then, after marking on the plan the N S E and W points, commence to mark off on the paper round the edge of the protractor the bearings of the survey. To check the accuracy of the plotting the corresponding bearing on the other side of the protractor should also be marked, then the line joining the two points thus marked off should pass through the point which marked the centre of the protractor. Thus if a bearing is N20 W, in addition to marking off this, the bearing S20E is also marked; this may confuse the student as to the difference (if any) between N20W and S20E. There is no difference in the line of sight, but simply in the direction in which the bearing is taken. If a sight taken from A to B is N20W, then the same sight taken from B to A is S20E. When plotting the first angle of a survey, care must be taken that it is in the proper direction.

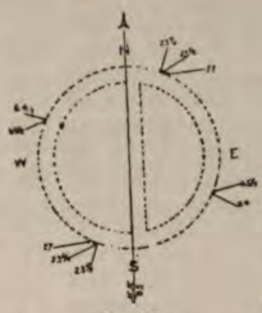


FIG. 89.

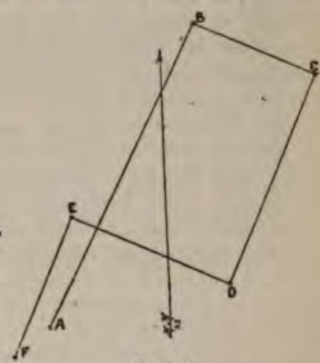


FIG. 90.

Fig. 89 shows how the bearings of the survey given on page 254, No. 22, Vol. II., are marked off. The bearings and lengths are as follows:—

LENGTHS.

(1) N27 E1325 from downcast shaft.
(2) S65½ E531
(3) S23⅝ W900
(4) N64 W622
(5) S23¾ W600 to upcast shaft.

The first bearing N27E, and the corresponding bearing S27W, are marked off with the pricker, and the figures 27 are pencilled near the marks on each side, so that they may be easily found; the same thing being done with the other bearings; the protractor is then removed and we have the markings on the paper as shown in the figure, the dotted lines showing the position which the protractor occupied.

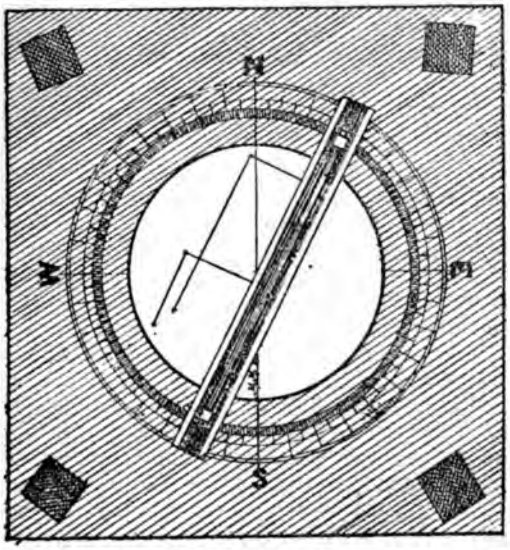


FIG. 91.

Now, if the position of the shafts is not already denoted on the paper, a point (A Fig. 90) is chosen in proximity to the markings to denote the downcast shaft and the plottings are commenced from this point. A parallel ruler is applied to the two points of the corresponding bearings of the first sight, and if the centre point of the protractor is in the same line, the bearings may be considered as correctly marked and the parallel ruler is moved along the paper to the mark A, which has been made to denote the shaft, and a line is drawn from this point in the proper direction, that is, towards B. The length of the line is then marked off by means of the scale to which it has been decided to plot the survey and another line is then drawn from the end point of the first, parallel to the line joining the markings 65½, in the same manner as the previous line was obtained. This line is marked off to the required length and so on with the other angles.

If when plotting a survey on a plan the meridian line is a distance away from the part in which the angles have to be plotted, a line is drawn parallel to the meridian line nearer, or even better, upon that part and the protractor is applied to this line, for if a number of lines be parallelled for a distance of several feet discrepancies are sure to arise.

Circular protractors are now made with one or two movable arms provided with verniers, and instead of marking the bearings off with a pricker, the vernier of the movable arm is adjusted to the bearing, and by a slight pressure at the end of the arm which carries a point, a small puncture is made in the plan, thus marking the bearing off much more accurately.

The best method of plotting mine surveys is by means of the cardboard protractor (Fig. 91). A meridian line is drawn over that portion of the plan at which the survey is to be plotted, and the protractor is placed so that the north and south line coincides with the meridian lines, and to prevent it from moving, plan weights are placed at each corner; the survey is then plotted on the plan on the space inside the graduated circle, the central portion of the card being cut away. To plot an angle the parallel ruler is placed at the bearing and on the corresponding bearing opposite, and is then paralleled to the station shown on the plan from which the survey was commenced; a line is drawn and the length marked off and subsequent bearings are plotted in the same manner. It is advisable to mark the centre of the protractor by drawing an east and west line so as to intersect the meridian or north and south line, so that a check may be obtained on the plotting. This method is very accurate and expeditious, and the plan is kept clean, as no marks other than the bearing lines have to be made upon it.

(To be continued).

AWARDS

FOR ANSWERS TO COMPETITION QUESTIONS.—No. 3 SET.

ELEMENTARY.—Jos. Wheatcroft, 8, Longsight Terrace, Kinsley Hemsworth, near Wakefield.
Commended.—J. H. Marsh, J. Saxton, J. B. Stuart, W. Jones, Thos. Webster, A. H. Harrison, A. W. Bullen, G. Tweddell.

ADVANCED.—J. Crone.
Commended.—J. Jones, S. Davies, S. Chadwick, N. Vickers, T. King.

FIRST-CLASS.—Geo. Daykin, 24, High Gurney Villa, near Bishop Auckland.
Commended.—J. Jackson, E. Jones, H. Daykin, T. E. Aitchison, J. P. Donohue, J. McPhail, J. Kiers, T. Wallett.

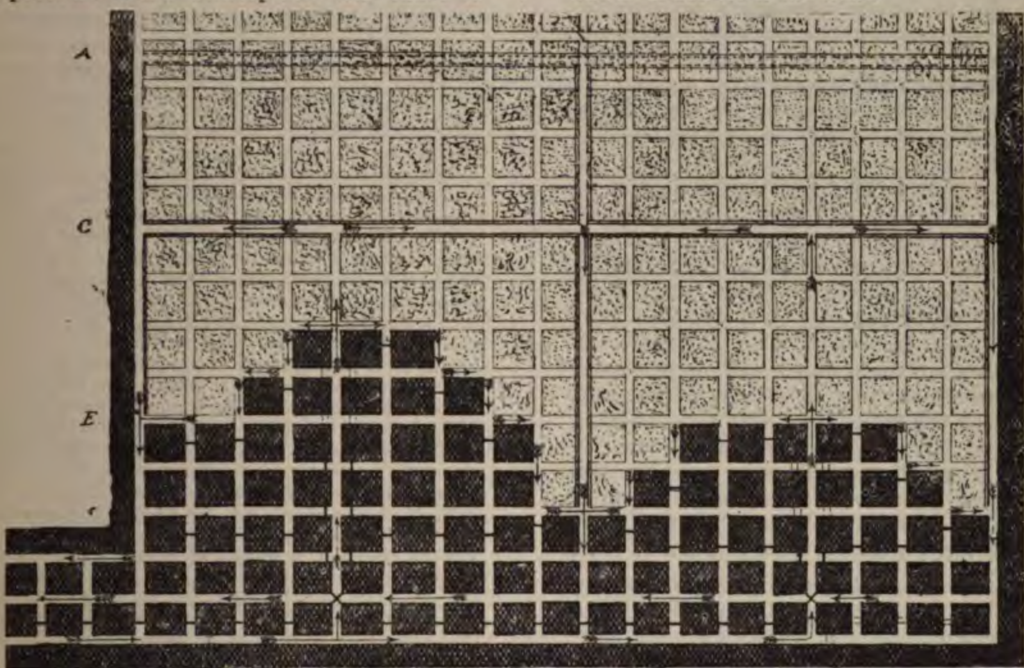
VENTILATION.

With references to incidents from personal experience
By JOSEPH CARTER,
First-Class Certificated Manager.

Accumulations of Gas and how to deal with them?

IN the two previous articles I have pointed out the dangers encountered from large accumulations of gas and how we overcame them, and I now purpose pointing out the dangers that arise in gaseous mines when working back the pillars from the rise. The removal of the pillars leaves a large space in which gas may accumulate in large quantities and at some later period a sudden decrease in the pressure of the atmosphere will cause it to expand and issue from the goaves in such quantities that the ventilation will be inadequate to remove it, and the result may be an explosion if there are any means of igniting the gas. Despite the utmost precautions it not unfrequently happens that miners work with defective lamps, either through ignorance or accident, and if such a case existed at the time of such an outburst of gas there would in all probability be a disaster. There is another point to be considered in a question of means of igniting the gas, which is even more dangerous, namely—blasting. Of all the sources of danger in a mine there is perhaps none in which the number of deaths could be minimised more than in blasting, if proper explosives are used and competent men appointed to fire the shots. Although experiments have shown that many recent safety explosives are not flameless, yet they also prove that if ordinary precautions are taken they are safe.

In cases such as we have instanced however, the best method of remedying them is to attack the source of the evil, namely—the gas, and by steady and constant removal prevent it from accumulating in large quantities in sufficient proximity to the working faces as will issue out to the workings before it can be dealt with.



TWO DISTRICTS OF BORD AND PILLAR WORKINGS.

The two principal circumstances which it is necessary to guard against are falls of roof and sudden depressions in the atmospheric pressure.

Falls of roof in the goaf (it is in such places that large falls are most frequent) are apt to drive the gas out of the goaf and foul the working places and thus render them extremely dangerous especially if the men are at work at the time.

Sudden depressions in the atmospheric pressure are still further to be feared, for they

cause a similar but larger occurrence through causing the gas to expand largely in volume. Rapid falls in the pressure of the atmosphere are by no means infrequent, and they may act on the gas so quickly that a disaster may occur before they are perceived.

The accompanying sketch shows two districts of bord and pillar workings in a fiery mine which had been cut out to the boundary the pillars being taken out as we receded. The pillars above the points A and B had been worked before any difficulty arose, and a large area of goaf had thus been left to the rise which it was impossible to ventilate, and in which a large amount of gas had accumulated. A depression in the pressure of the atmosphere had therefore the effect of driving a portion of this gas downbrow and thus fouled the workings. In order to prevent further outbursts into the working places, we determined to keep the lower portion of the goaf as free from gas as possible, so that in case of an outburst there would be a large area for the gas to expand in before it reached the working places. We effected this by building a pack road along the full length of the goaf from A to B, and as we receded, built a similar road in the centre as a return airway and allowed a quantity of air to circulate along the level pack road A B. The goaf up to the road A B was thus kept comparatively free from gas, and on such occasions when there was a fall in pressure, the gas filled into this level and partly into the goaf on the lower side, but the constant ventilation always removed it before it reached the pillar workings. When the pillars had been won to about 100 yards below A B, another pack road C D was left, and afterwards a similar road was left at E F.

With these precautions we dealt successfully with the gas, and anything like large accumulations at the workings were prevented. Of course such a method as we adopted would be a needless expense in a non-fiery mine, but it was without doubt the most economic and safest arrangement that could be made under the circumstances. In fiery mines the strictest discipline should be maintained, and the management should exercise much care and forethought to prevent anything that might result in a disaster.

All correspondence for publication can be sent at book post rates, providing the ends of the envelope or package are left open for inspection.

EXPLOSIVES.

Review of Experiments and Discussion.

A SHORT time ago* we published the results of some experiments with explosives at Wigan which were conducted by the syndicate of a new explosive, Westphalite, and the general publication of these results has caused a vast amount of discussion.

Mr. House, as chairman of a meeting in connection with the Lancashire and Cheshire Association of Under-Managers, stated that the experiments were valueless, as none of the makers of the explosives in question claimed for their respective commodities the virtue of flamelessness in a naked state without tamping, and that it was a preposterous method of experimenting as this is not the condition in which shots are fired underground and that in consequence no importance can be attached to the results. He also proceeded to say:—

There are so many things which, to my mind require further explanation than the report affords. The first consideration is that of deliquescence, that is the liability of the explosive to become affected by moisture. If this Westphalite is very liable to moisture, and is in a moist state when fired in the experimental cannon, it might refuse to be completely exploded with a No. 6 detonator, and the fumes from the portion unexploded would tend to suffocate any flame arising from the explosion of the detonator and a part of the explosive substance. In this case inflammable gas would not be fired. Now comes the great question of the action of detonators upon the explosive substance to effect complete combustion of a physically dry and chemical correct charge. Some explosives require stronger detonators than others do to effect this result. Roburite for instance can be fired when dry with a No. 6 detonator, containing one gramme, or 15·432 English grains of fulminate of mercury, and the consequence is complete explosion. If a No. 4 detonator, say, was used with Roburite the result would always be partial explosion, and often no ignition of gas in the experiment tank even if untamped. Therefore, if Westphalite in the recent experiments has been used with a detonator of insufficient strength the result would be partial combustion, and very often, perhaps always, no explosion of gas would follow. Now let us see if the right number of detonator was used with Westphalite. The report states that No. 6 detonator was used in each experiment. This is the right detonator for dry Roburite, but is it for Westphalite? Remember if a charge of explosive does not perfectly explode it is no use for blasting in our mines. I will read an extract from page 1 of the pamphlet issued by the Westphalite Company, to see what they have to say in this matter of detonators. The passage reads—" Westphalite can only be exploded with very strong detonating caps charged with 1½ to 2 grammes

* No. 25, Vol. II.

of fulminate of mercury; without these it is not an explosive." Now, gentlemen, if it is not an explosive it cannot be of any use. The size of the detonator containing 1½ grammes of fulminate is No. 7, and the size containing two grammes is No. 8. Therefore, according to the Westphalite Company's pamphlet, the substance issued in the experiments at Messrs. Pearson and Knowles' Collieries being only connected to a No. 6 or one gramme detonator is, according to their own words, no explosive at all, and would be of no use in blasting operations. Westphalite, according to the patent specification, is composed of nitrate of ammonia and gumlac. I have witnessed the effect of a mixture of 90 to 92 per cent. of nitrate of ammonia with 8 to 10 per cent. of gumlac (although this may not be the percentage adopted by the Westphalite Company) in the experiment tank with an explosive mixture of gas and air and with No. 6, No. 7, and No. 8 detonators respectively. The result with No. 6 detonator was combustion and not ignition, with a No. 7 the result was similar, but with a No. 8 an explosion resulted, and the gas was fired. In each of these three experiments there was no tamping used. What we ought to know is whether the Westphalite Company are willing to submit their explosive, in the form put upon the markets for use, to the test of experiments with No. 7 or No. 8 detonators in an untamped state in an explosive atmosphere. Not that I would consider it any detriment to its safety if it did fire the mixture of gas and air in an untamped state (for I have already expressed my views upon that matter) so long as it safe with the assistance of the minimum amount of tamping as used in mining work

Mr. W. J. Orsman, F.I.C., F.C.S., Chemist for the Roburite Explosive Company, in the course of a lecture on explosives at the same meeting said:—

With regard to the future, there is every reason to suppose that gunpowder and all compounds containing nitro-glycerine will be replaced by the safer compounds of the Sprengel class. Even Carbonite, which is perhaps the safest of the mixtures containing nitro-glycerine, is a dangerous substance, owing to the liability to freeze, to explode on being struck, to its catching fire and burning when in contact with a light or spark, and to the very poisonous gases which are given off on burning or detonation. Lately an explosive of the Sprengel type has been introduced, called Westphalite, consisting of an intimate mixture of nitrate of ammonia with resin or shellac. Owing to the great inertness of the resin, a very strong detonator, containing 2 to 2½ grammes of fulminate of mercury, is required to completely detonate the mixture. If a weaker detonator is used, for instance a No. 6, only part of the cartridge explodes, the rest being scattered about. In such a case the scattered particles become decomposed by the heat evolved, and so reduce the temperature of the flame. If however, a high power detonator be used, total combustion will take place, and the heat evolved is sufficient to ignite explosive mixtures of gas and air. No explosive in which complete detonation takes place ever has, and I venture to think ever will, be produced that will not generate sufficient heat to ignite an explosive mixture of gas. Owing to the method of manufacture, the above explosive is extremely sensitive to moisture, and consequently liable to mis-fire.

Mr. H. A. Krohn, Secretary of the Roburite Company, in a published letter, states in contradiction to some of the statements made by the Westphalite syndicate:—

(1st) The explosive (Westphalite) has up to the present only been used experimentally in Saxony (2nd) The railway regulations for the transit of this explosive on the continent are the same as apply to Roburite, and have been in force for several years. (3rd) In report of experiments carried out by the Westphalite syndicate at Sinsen, Germany (1893), No. 2 coal carbonite 178 grammes (less than 6 oz.) in 4 litres, coal dust without gas or benzine ignition flame 15 metres long, charring. (4th) In the pamphlet issued by the Westphalite syndicate Westphalite can only be exploded with very strong detonating caps, charged with 1½ to 2 grammes of fulminate of mercury; without this it is not explosive.

In the experiments conducted a detonator (No. 6) containing only 1 gramme of fulminate of mercury was used. Either, therefore, the Westphalite syndicate used a detonator which, by their own showing, was too weak to thoroughly detonate the explosive, in which case the safety tests were entirely illusory.

Mr. J. Higson, in a letter referring to the meeting in connection with the Association of Under-Managers, states:—

The Chairman on that occasion, Mr. J. House, after enlightening his hearers on the general subject of explosives, referring to "Roburite" acknowledged the fact that this explosive when fired into an apparatus containing an inflammable mixture of gas and air, without any tamping. always produces an explosion of such atmosphere. That a vast number of untamped shots are daily fired in our coal mines is only too apparent . . . It was never intended for a moment to fire Westphalite for coal-blasting in a naked state; for without tamping no blasting results could be obtained, but having regard to the frequent occurrence of untamped shots and blown out shots as already explained, all experiments for testing the safety of explosives in the presence of inflammable mixtures of gas and air, or coal dust, should be made with untamped shots only.

Mr. Orsman states that Westphalite is extremely sensitive to moisture. It may be interesting to know that the Westphalite used in the experiments was manufactured in June last . . . and arrived in the magazines in England in the early part of August . .

Mr. Orsman's opinion that a No. 6 detonator would only partially explode Westphalite, the rest being scattered about, is incorrect. In order to prove the contrary of this assertion I must refer your readers to the results of the official tests of October 24th, reported on the propulsive tests.

If only a portion of the Westphalite had exploded, as Mr. Orsman suggests, when fired with a No. 6 detonator the shot would not have traversed half the distance... I will submit Westphalite to the test with, up to, and including a No. 10 detonator.

In a letter on the above subject, Mr. John Knowles, of Messrs. Pearson and Knowles Coal and Iron Co., says:—

It is monstrous to suggest or doubt the report signed by Messrs. Mathews, H.M.I.M., R. Isherwood, J.P., Miners' Agent, and J. Burrows, who in the public

interest superintended the experiments at these collieries on Oct. 24th, when Westphalite undoubtedly proved to be the safest for use in coal-blasting, carbonite and ardeer powder being out of the running on account of their inferior power. From the results of experiments which I have since conducted with other managers connected with collieries I am perfectly satisfied that either a No. 6, 7, 8, 9, or 10 detonator will completely detonate and explode Westphalite, and without igniting a highly inflammable mixture of coal dust and fire-damp when fired under the severe conditions of an untamped shot—the experiments we made underground being very satisfactory.

The Carbonite Syndicate, Limited, have published a letter in defence of Carbonite, from which the following is extracted :—

In the report of the committee appointed to test the safety of Westphalite as compared with other explosives it was found that not only the last-named explosive but also carbonite and ardeer powder stood the test made in coal dust and gas mixtures, whereas roburite and other explosives caused ignition. This awkward result, naturally, rather interfered with the anticipated triumph of Westphalite, but it was promptly ascribed to inferior explosive power of carbonite and ardeer powder as proved by the mortar test. The mortar test was, however, never regarded as a reliable means of measuring the comparative strength of explosives with different velocities of combustion. It stands to reason that a quick explosive has time to fully develop its gases before the projectile leaves the mortar, while slow explosives like carbonite, ardeer powder, and gunpowder, can only develop their maximum expansion after the projectile has left the mortar. The Traulz cylinder test gives more correct results, but the only true standard for coal mining explosives is, as is well known, to be found in practical blasting, and no one will, we presume, even suggest it is a disadvantage for an explosive intended for that work to be slow in action.

The Carbonite Syndicate, Limited, also attempted to show that contradiction No. 4, in Mr. Krohn's letter, as given above, *re* the Sinsen experiments as published by the Westphalite Syndicate, is an error which so far as they were aware had been corrected by the Westphalite Syndicate. But in a more recent letter Mr. Krohn replies that it is not corrected in the published results which he possesses of the Sinsen experiments.

The above extracts will give the reader a general idea of the discussion which has taken place *re* the experiments near Wigan, and we doubt if any further proof or any new argument is forthcoming which will enable us to form a correct and trustworthy opinion of the respective merits of the explosives in question. For the present the reader must form his opinion from the experiments, statements, and arguments at hand to the best of his ability, as we do not pretend to be able to help him materially. We have, however, a few words to say with reference to some details of the experiments.

In the first place we are of opinion that experiments should be made with untamped shots, for although such a condition is not the one in which shots are usually fired yet it is advisable to prepare for such a contingency, as it is so easy for such an occurrence to take place either by accident or through ignorance. There is practically no limit to safeguards for prevention of accidents in mines, and if it is possible to manufacture an explosive that will be safe under all conditions, then this should take the preference. In actual practice there may not be more than one untamped shot fired in a hundred thousand, yet that is no reason why an endeavour to prevent the possibility of danger from the isolated case should be scouted, provided that it is also safe in the remainder. With reference to the number of the detonator with which a shot should be fired in experiments, we do not agree that taking a certain number of detonator and using it to all the explosives is a correct method, for if an explosive can be fired with a No. 4 detonator and gives safe and satisfactory results, it is unfair to fire it with a No. 6 which may make it unsafe; for where is the necessity of firing this explosive in actual practice with a more powerful detonator than it requires.

Experiments have been recently conducted by a committee in connection with the North of England Institute of Mining and Mechanical Engineers on so called flameless explosives, with the result that flame was given off by all. If these experiments are of any importance it is regrettable that the new explosive, Westphalite, was not included in the experiments. One condition of the latter experiments with which we are not favourably impressed is the small weight of explosive used. These varied from 1 to 3½ oz., according to the strength of the explosive, and the reason for selecting these small weights was owing to the appliances, which were not capable of dealing with larger shots. The detonator employed in all cases was No. 6, and this gives rise to another difficulty. The fulminate of mercury employed in the detonator being a non-safety explosive, the explosive being experimented upon had not only to quench flame from itself but also that of the detonator, and as the charge was so small it had not a fair opportunity of doing this. In all probability the results would have been different had a larger charge been adopted, such as would be used in blasting underground.

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N.B.—For pages 121-3 read page 34.

ABBREVIATED DESCRIPTION
OF THE
COALFIELDS OF GREAT BRITAIN.

SOUTH WALES COALFIELD.—Second largest in Britain. In form it is like a trough. The beds rise and crop out towards the north, and the Millstone Grit, and the Carboniferous Limestone come in. It is divided into two portions by Carmarthean Bay, the eastern portion extending for 56 miles and the other 17 miles to St. Bride's Bay. The larger portion is traversed throughout by an anticlinal axis, which brings a considerable area of the lower seams within reach of mining operations. A remarkable change takes place in the coal of this field. In the eastern portion the coal is bituminous, in the centre semi-bituminous, and in the west anthracite. Faults range in a N N W direction and are parallel to each other. Contains 25 seams of 2 feet and upwards with a thickness of 85 feet of workable coal. Area 906 square miles.

BRISTOL AND SOMERSETSHIRE COALFIELD—Extends from Mendip Hills northward 26 miles and consists of two basins, the smaller being situated principally in Gloucestershire and the larger in Somersetshire, being divided from each other by a broken anticlinal. On the west and north-east the coal measures rest upon Mountain Limestone, on the east they are covered by the Bath Oolites, and on the south along the northern base of the Mendip Hills the measures assume an almost vertical position, have sometimes a reversed dip and are much contorted. A characteristic of the coalfield is that a large part is covered by unconformable strata, which is almost horizontal whilst the coal measures have a considerable dip. Contains 63 seams of coal only, 20 of which are above 2 feet thick, giving a total of 71 feet of coal. Area 180 square miles.

FOREST OF DEAN COALFIELD.—This small coalfield forms almost a perfect basin, the seams dipping from all sides towards the centre being bounded by the Mountain Limestone on which they rest. It contains 15 seams, 8 of which are workable and has an area of about 34 square miles. The Coleford High Delf Seam of this coalfield is remarkable for the horse or wash-out which traverses it.

FOREST OF WYRE COALFIELD (WORCESTER).—This coalfield has abont the same area as the Forest of Dean. The seams are thin and of inferior quality only one or two of them being workable. The coal measures rest upon a bed of Old Red Sandstone.

SHREWSBURY COALFIELD.—This coalfield forms a narrow band about 18 miles long, by 1 mile broad, and similar to the foregoing it rests upon older rocks without the intervention of the Millstone Grit and the Carboniferous Limestone, but in this case the fundamental rocks belong to the Cambrian and Lower Silurian periods. It contains two or three seams which are workable under favourable circumstances.

COALBROOK DALE COALFIELD.—This is of a triangular form with its base near Coalbrook Dale and its northern apex at Newport. It is bounded on the north-west by a large fault which brings in the New Red Sandstone, on the east by the Permian Rocks under which it passes, and on the west by the Silurian Rocks. It contains six workable seams of coal with a total thickness of 27 feet, besides several rich beds of ironstone. Area 28 square miles.

NORTH WALES COALFIELDS.—These coalfields consist of the Denbighshire coalfield on the south, and the Flintshire coalfield on the north, these being divided by a tremendous fault north of the valley of the Alyn. The Denbighshire coalfield has an area of about 47 square miles, and contains seven workable seams with a total thickness of 30 feet of coal. The Flintshire coalfield has an area of about 35 square miles, and contains about six workable seams with a total thickness of 35 feet of coal. The coal measures in all probability extend under the intervening New Red Sandstone from Flintshire to Lancashire and Cheshire.

SOUTH STAFFORDSHIRE COALFIELD.—This coalfield lies between two large faults ranging north and south, which have raised the coal to a workable limit. It contains six workable seams with a thickness of about 65 feet of coal. The most valuable seam of coal is the *Thick* or 10 yard seam, but unfortunately it is almost worked out. In the northern part of the field this seam splits into nine distinct seams, which have a total thickness of about 30 feet of coal, but separated by 140 yards of strata. Area 150 square miles.

NORTH STAFFORDSHIRE COALFIELD.—This coalfield is triangular in shape the apex being towards the north. The base of the triangle is about 10 miles in length, and the area is about 75 square miles. The coalfield is bounded on the east by the Millstone Grit, and on the west and south by the Permian beds and New Red Sandstone. The measures of this field are very rich, beds of ironstone

occuring as a roof to the coal seams. It contains about 30 workable seams with a thickness of about 150 feet of coal.

CHEADLE COALFIELD (STAFFS.)—This small coalfield contains several workable seams and extends about 5 miles north and south, and 4 miles east and west. The centre of the coalfield is covered by an outlier of unconformable New Red Conglomerate.

CHESHIRE COALFIELD.—This is a small coalfield formed by the middle and lower coal measures of Lancashire, and is bounded on the west and south-east by two large faults. It contains several valuable seams of coal.

LANCASHIRE COALFIELD.—This is one of the most important of the British coalfields, and is situated in the south of Lancashire and east of Cheshire. It is terminated on the west by a large down-fault which brings in the New Red Sandstone, and is bounded on the north and east by Millstone Grit, and on the south the measures dip under newer formations. It contains about 17 workable seams and a valuable seam of cannel coal which unfortunately however thins out in every direction from Wigan. The total thickness of workable coal is about 62 feet. Numerous large faults traverse the coalfield parallel to each other in a N N W direction. Area about 217 square miles.

BURNLEY COALFIELD (LANCASHIRE).—This is a small detached portion lying a few miles north of the main coalfield. It contains about 12 workable seams with a total of 40 feet of coal, its area being about 20 square miles.

CUMBERLAND COALFIELD.—This coalfield has an area of about 25 square miles, and is situated near Maryport, Workington and Whitehaven. The lower seams extend under the sea, and at Whitehaven the coal has been followed over 3,000 yards. The aggregate thickness of workable seams is about 35 feet,

WARWICKSHIRE COALFIELD.—The area of this coalfield is about 90 square miles, and there are five workable seams in the north with a thickness of about 30 feet of coal. About 120 feet of shales and sandstones separate the seams at this point, but these gradually thin out towards the south to such an extent that the five seams combine to form a seam of 26 feet in thickness. The area of the coalfield is no doubt much larger than given above, as it is thought the seams may be found under newer formations.

LEICESTERSHIRE COALFIELD.—This coalfield is divided into three districts—Moria on the west, Ashby-de-la-Zouch in the centre, and Coleorton on the east. The central portion is formed of lower coal measures, and is practically valueless, but a downthrow fault on each side brings in the workable seams of Moria and Coleorton. There are about 10 workable seams with a total of 45 feet of coal. The productive area is about 15 square miles. Total area 30 square miles.

MIDLAND COALFIELD (NOTTS, DERBY, YORK.)—This is the largest coalfield in England, having an area of about 760 square miles. It is bounded on the north and west by the Millstone Grit, on the south by the New Red Sandstone, and on the east it extends beneath the newer formations of the Magnesian Limestone. It stretches from Derby on the south to Bradford and Leeds on the north, its length being about 66 miles. It contains about 15 workable seams with a total of 46 feet of coal, the dip of the seams being generally towards the east. Prof. Ramsey estimates a concealed coalfield of 900 square miles in addition to the area given above.

NORTHUMBERLAND & DURHAM COALFIELD.—The structure of this coalfield is an irregular basin or trough, extending from Staindrop near the north bank of the Tees on the south, to the mouth of the Coquet on the north, the distance being nearly 50 miles. On the north-east the coal measures extend beneath the sea, on the south-east beneath the Magnesian Limestone, and on the west the lower carboniferous rocks crop from beneath the coal measures. It contains 16 workable seams of 18 inches and upwards, giving a total of about 46 feet of coal. Area of visible coalfield is about 460 square miles, but 330 square miles more may be added to this area for available coal under the sea and Permian rocks

CLYDE COALFIELD.—The river Clyde passes through the whole length of this coalfield, which includes portions of Renfrewshire Dumbartonshire, Stirlingshire, and the whole of Lanarkshire. It is broken up by intrusive sheets of dolerite and melaphyre, which are a source of great trouble and expense in the working of the seams. It is also traversed by dykes of basalt and dolerite. This coal field is noted for the Boghead Gas Coal, and also for its blackband ironstone, both of which are however nearly exhausted. It also contains other valuable seams of coal.

MIDLOTHIAN & HADDINGTON COALFIELDS.– These coalfields consist of a double trough, one of which lies in Edinburghshire on the west, and the other in Haddington on the east, a ridge being formed between the two troughs by the Roman Camp limestone. There are several seams of valuable coal in each of these coalfields.

FIFESHIRE COALFIELD.—This coalfield is of considerable extent, but is much dislocated by faults and damaged by intrusive igneous rock. Nearly the whole of the coal seams enter the sea between Kirkcaldy and East Wenyss. It contains about 28 seams, of over 2 feet in thickness, with a total of 120 feet of coal.

CLACKMANNAN COALFIELD.—This coalfield is divided into three districts by large faults, and it is separated from the Clyde coalfield by the River Forth. It contains about ten seams, of two feet and upwards, with a total of 40 feet of coal.

AYRSHIRE COALFIELD.—This coalfield stretches along the coast from Ardrossan to the mouth of the River Doon. It is a rich and productive district, containing several seams of fair thickness.

LESMAYHAGOW COALFIELD.—This is a detached basin, which lies south of the Lanarkshire portion of the Clyde coalfield. It is about 7½ miles from east to west and from north to south, and has a thickness of 53 feet of coal within a depth of 200 fathoms.

CANOBIE COALFIELD (DUMFRIES).—This is a small but valuable tract, containing seven seams, of three feet and upwards, with a total of 37 feet of coal.

BRORA COALFIELD (SUTHERLAND).—This coalfield belongs to the Lower Oolitic period, and only contains two workable seams.

In the Isle of Skye is a small coalfield, probably of the same period, which contains a five feet seam of coal.

THE COALFIELDS OF IRELAND. The coalfields of Ireland are situated in the following districts—Ballycastle (Antrim), Tyrone, Queen's County, Kilkenney and Carlow, Tipperary, Clare, Limerick and Cork, Connaught (Arigna District). All the coals north of an imaginary line drawn from Galway Bay to Dublin Bay are bituminous, while those on the south are anthracite. The resources of the Irish Coalfields have not been made as much use of as there worth would warrant, but in all probability there will be an improvement in this respect.

The above estimates have been based principally from Mr. Hull's calculations.

Information for Candidates for Certificates.

Names and Addresses of

H.M. INSPECTORS OF MINES, SECRETARIES OF THE BOARDS FOR EXAMINATIONS, AND DATES OF GOVERNMENT EXAMINATIONS.

[a] Chief Inspector. [b] Secretary to Board for Examinations.

1. *Scotland East District—May.*
(*a*) J. B. ATKINSON, Esq., 10, Foremount Terrace, Glasgow.
(*b*) ROBERT CALDER, Esq., 3, Fintry Place, Broughty Ferry, N.B.

2. *Scotland West District—November.*
(*a*) J. M. RONALDSON, Esq., 44, Athole Gardens, Glasgow.
(*b*) STUART FOULIS, Esq., 140, Hope Street, Glasgow.

3. *Newcastle District—January.*
(*a*) J. L. HEDLEY, Esq., 22, Hawthorne Terrace, Newcastle-on-Tyne.
(*b*) M. WALTON BROWN, Esq., Neville Hall, Newcastle-on-Tyne.

4. *Durham District—July.*
(*a*) THOMAS BELL, Esq., Shamrock House, Durham.
(*b*) GEORGE BARTLETT, Esq., Red Hall, Houghton-le-Skerne, Darlington.

5. *Yorkshire and Lincolnshire District—June.*
(*a*) FRANK N. WARDELL, Esq., Wath-upon-Dearne, Rotherham.
(*b*) JOHN R. JEFFERY, Esq., Solicitor, 5, Piccadilly, Bradford.

6. *Manchester District—December.*
(*a*) JOHN GERRARD, Esq., Worsley, Manchester.
(*b*) T. RATCLIFFE ELLIS, Esq., Wigan.

7. *Liverpool District—June.*
(*a*) HENRY HALL, Esq., Rainhill, Prescot.
(*b*) T. RATCLIFFE ELLIS, Esq., Wigan.

8. *Midland District—October*
(*a*) A. H. STOKES, Esq., Greenhill, Derby.
(*b*) W. SAUNDERS, Esq., Wilson Street, Derby.

10. *North Staffordshire District—June.*
(*a*) W. N. ATKINSON, Esq., Newcastle-under-Lyme.
(*b*) JOS. KNIGHT, Esq., Newcastle-under-Lyme.

11. *South Staffordshire District—January.*
(*a*) W. B. SCOTT, Esq., Farlands, Great Barr, Birmingham.
(*b*) W. BLAKEMORE, Jun., Esq., Aldridge, near Walsall.

12. *South-Western District—September.*
(*a*) J. S. MARTIN, Esq., The Vikings, Durdham Park, Bristol.
(*b*) S. J. THOMAS, Esq., Forest House, Coleford, Glos.

13. *South Wales District—March.*
(*a*) J. T. Robson, Esq., St. Helen's Road, Swansea.
(*b*) R. V. Rees, Esq., Glandare, Aberdare.

Inspectors of Metalliferous Mines.

North Wales, etc., and the Isle of Man.

C. Le Neve Foster, Esq., Llandudno, N.W.

The numbers of the districts correspond with those on the map.

How to Prepare for the Examination.

To pass the examination it is not sufficient for a candidate to know the necessary subjects thoroughly, but also to be able to express himself clearly, briefly and quickly, and many candidates find a difficulty in doing this if they have not previously acquainted themselves to it by frequently writing out essays, answers to questions, etc.

Notes should be made of any new method or arrangement which the candidate may chance to see and a description should be written afterwards.

The Competitions which we give in each issue of our journal are the best possible means a candidate could have to prepare himself for the examination. The questions are given for the competitor to answer, and the correct answers are subsequently published: thus enabling a candidate by comparing the answers to see in what he is lacking, so that he can endeavour to remove the deficiency.

A greating stumbling of the examination to many candidates is the plan of working, which it is required should be ventilated. This can only be done correctly if the candidate has made frequent attempts to show the ventilation on skeleton plans such as have been given at previous examinations.

Subjects which a Candidate Should Learn

MINING PROPER.

Boring, sinking, systems of working, various plant arrangements, ventilation, mine gases, haulage, timbering, tunnelling, how to minimise and deal with accidents, etc., etc.

EXTRA SUBJECTS.

Mathematics—Proficiently.
Geology—A fair knowledge of, more particularly with the Carboniferous period.
Mechanics—Practical and theoretical, cover the syllabus of elementary grade, S. K. Science and Art Exam.
Steam and Steam Engine—Cover syllabus of advanced grade, S. and A. Exam. This includes a knowledge of heat.
Atmosphere—General knowledge of the properties, etc.
Chemistry—Elementary knowledge of, with special study of mine gases, explosives, etc.
Drawing—Freehand sketches, quickly, of machinery and other mining appliances and constructions.
Electricity—Elementary knowledge of, generally, with special study of such parts as are applied to mining operations.
Surveying—How to make fast and loose needle surveys and levelling and plotting of same. This includes geometry and mensuration.
C.M.R.A.—To be known thoroughly.
Ambulance Work—General knowledge of.

GEOLOGY EXAMINATION.

S. & A. Dep., 1893.

ELEMENTARY.

Instructions.

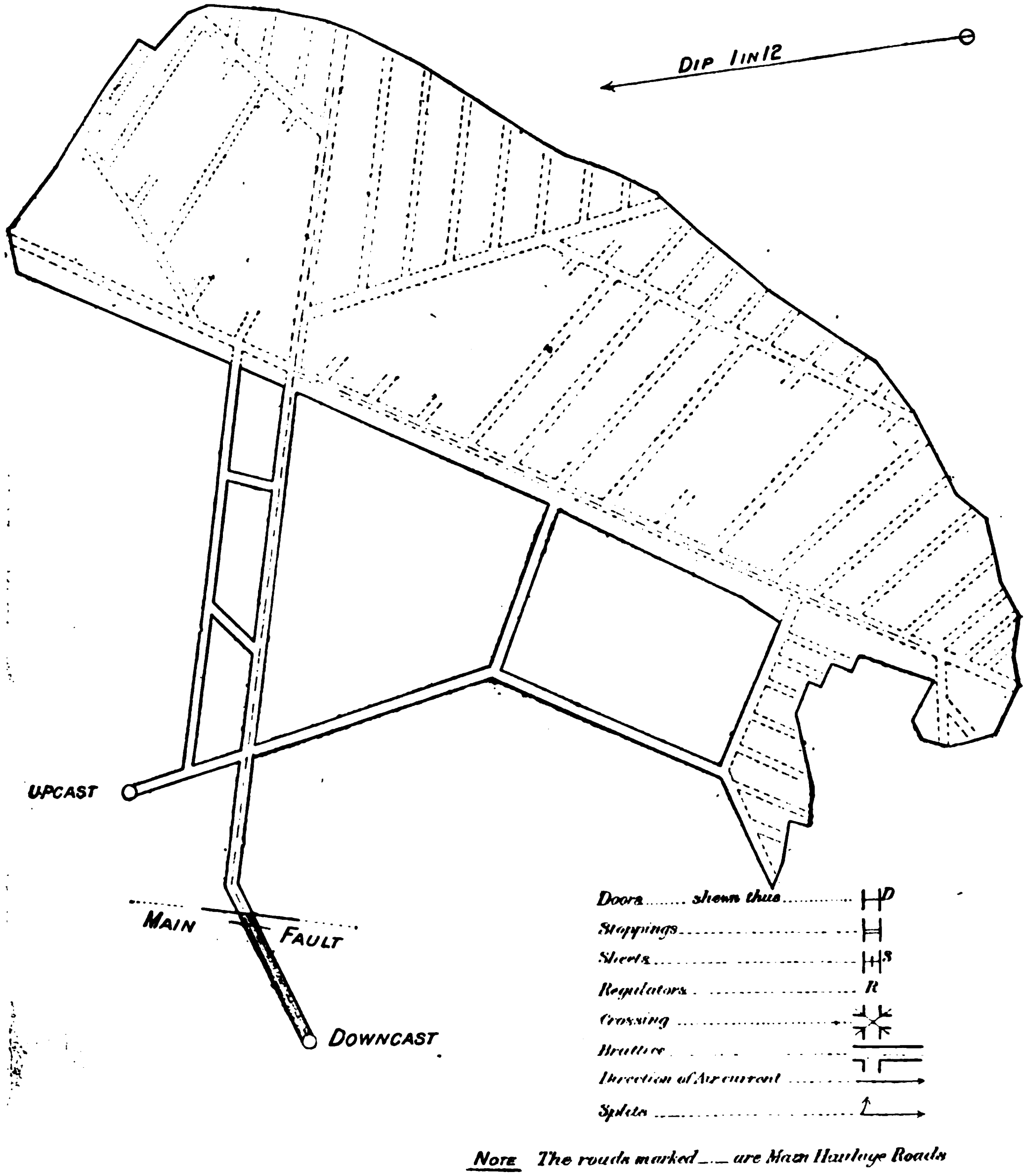
You are permitted to attempt six *questions only.*

1. Describe the terms *Chert*, *Gneiss*, *Mica-Schist*, *Tuff*. (20.)
2. Describe *Blown Sand*. How would you recognise grains of such sand in sandstone? (20.)
3. In what way may *Breccia* be formed? (15.)
4. Describe how a soft calcareous deposit may be converted into crystalline limestone (15.)
5. Draw a diagram showing *Trough-Fault*, *Inverted Strata*, and *Inlier*. (15.)
6. What is *Amber*? Where does it occur, and what fossils does it often contain? (15.)
7. In what British strata do the oldest known Mammal, Bird, and Fish occur? (15.)
8. What is meant by the term *Hardness* as applied to Water? How is this hardness produced? (15.)
9. Fossil shells are often scarce in sandstones. Why is this? (15.)
10. Explain the terms *Bedding* and *Cleavage*. How would you distinguish these in a rock? (15.)

COLLIERY MANAGERS' EXAMINATION QUESTION.

MANCHESTER DISTRICT, DECEMBER, 1893.

This Sketch shows Ventilation Plan given at the above Examination.



*NOTE.—We will criticise a Student's attempt of Ventilating the above Plan, and **return him the** Plan correctly ventilated, at a charge of Sixpence to defray expenses.*

MINE VENTILATION MADE EASY.*

For the Use of Mining Students, Fire-Men, Mine Foremen, and Mine Officers Generally.

By W. FAIRLEY, F.G.S.

PART I.

FACTS, RULES, SCIENTIFIC MEMORANDA, AND MAXIMS RELATING TO AIR, GASES, COLLIERY EXPLOSIONS, AND THE VENTILATION OF MINES.

1. Pure atmospheric air consists of a mechanical mixture of seventy-seven parts by weight of nitrogen and twenty-three of oxygen, with small portions of carbonic acid and ammonia, and a varying proportion of watery vapour.

Many impurities have been found in the air of towns by examining the rains which have fallen. The air at the sea-coast, and at great heights, is the freest from impurities, and the proportion of ammonia is found to decrease in ascending. The organic matter contained in the air depends very much upon the density of the population. The return air of mines is often very much vitiated in its passage through the excavations.

2. The mean temperature of the air in Philadelphia is 68·6 degrees Fahrenheit in summer, and 38·3 degrees Fahrenheit in winter. The temperature of air in the interior of mines, especially deep mines, is pretty nearly constant all the year round, this fact, coupled with that of the variation of temperature at the surface, accounts for the uncertainty of natural ventilation.

3. The weight of air is about 31 grains per 100 cubic inches at ordinary pressure and temperature, but it varies according to the reading of the barometer. It becomes less and less in weight as we ascend; the weight of a cubic foot at sea-level under ordinary conditions is ·076097 pound. It becomes lighter as the temperature increases: thus, 1000 cubic feet at 32 degrees Fahrenheit weigh 81 lbs.; at 110 degrees 1000 feet weigh 70 lbs.; and at 200 degrees 60 lbs.

4. The average pressure of the atmosphere at the level of the sea is equal to 14·7 lbs. per square inch, or 2116·8 lbs. per square foot. The total pressure on the convex surface of the earth was calculated by the late Dr. Olinthus Gregory to amount to 10,686,000,000 hundreds of millions of pounds. This may be expressed as ten trillions, six hundred and eighty-six thousand billions. Sir John Herschel's calculation of this was 11$\frac{3}{4}$ trillions of pounds, which is about ten per cent. more than that of Dr. Gregory.

5. It is calculated that at a height of about 3$\frac{1}{2}$ miles above the sea level the weight of a cubic foot of air is only one-half what it is at the surface of the earth, at seven miles only one-fourth, at fourteen miles only one-sixteenth, at twenty-one miles only one-sixty-fourth, and at a height of over forty-five miles it becomes so attenuated as to have no appreciable weight.

6. The opinion is generally held that atmospheric air encircles the earth for a distance of forty-five miles from the surface, and that a column of air that height, one of water 32 to 34 feet high, and one of mercury of about 30 inches high, on an average balance each other.

7. A man cannot breathe at a greater height than seven miles from the surface. On one occasion when Mr. Glaisher, the celebrated aeronaut, had attained a height of over four miles in a balloon, his hands became quite blue, and he experienced a qualmish sensation in the brain and stomach, resembling the approach of sea-sickness—great cold and a difficulty of breathing was likewise felt.

8. Air is 821 times lighter than water; the student may calculate this for himself from the following data—air in ordinary conditions weighs ·076097 lb. per cubic foot, water 62·5 lbs., then dividing one into the other he will get 821.

9. A fall in the barometer of one inch represents a reduction in the pressure of the atmosphere of half a pound per square inch or 72 lbs. per square foot, so that an underground excavation six feet square, with an increase of an inch in the barometer, has an increased pressure on the face of 2592 pounds.

10. The pressure of the atmosphere increases with the depth of shafts, equal to about one inch rise in the barometer for each 150 fathoms increase in depth; this may be taken by practical miners as a rough and ready rule for ascertaining the depth of shafts.

11. Both the barometer and thermometer show a lower reading in ascending from the surface; for example, at a height of 20,000 feet, the temperature is 40 degrees less than at the surface, and the reading of the barometer is only about one-half of the reading at the surface, but the variation both in temperature and pressure is not regular. In the month of August on one occasion Mr. Glaisher found the temperature to be 24 degrees at a height of 23,000 feet.

12. It is generally reckoned that the temperature of the rocks composing the earth gradually increases in descending from the surface at the rate of one degree on the

* *Reprinted from the Colliery Engineer and Metal Miner by special permission.*

Fahrenheit scale for every 60 feet increase in depth, but different results have been obtained by various observers on the question.

14. Mine ventilation is understood to mean the provision for a constant supply of fresh air, and its regular flow throughout the underground workings, in a sufficiently copious quantity to destroy the vitiating effects of the carbonic acid, and water added to it by the breathing of animals and burning of lights, by the gases issuing from the rocks, or by any other noxious emenations, all of which should be carried away as fast as they are engendered.

15. Although 666 cubic feet of air have been reckoned sufficient to sustain a man for twenty-four hours, much more than that should be reckoned upon. By section 7, Article X, of the *Anthracite Mine Law of Pennsylvania, 1891*, it is provided that: "All air passages shall be of a sufficient area to allow the free passage of not less than two hundred (200) cubic feet of air per minute for every person working therein."

The Bituminous Mine Act of Pennsylvania, June 30, 1885, provides that: "The owner or agent of every Bituminous coal mine, whether shaft, or slope, or drift, shall provide and hereafter maintain for every such mine ample means of ventilation, affording not less than one hundred cubic feet per minute for each and every person employed in the said mine, and as much more as the circumstances may require, which shall be circulated around the main headings and cross-headings and working places to an extent that will dilute, carry off, and render harmless the noxious or dangerous gases generated therein."

Section 1, of Article IV., of An Act Supplementary to the Bituminous Mine Act of Pennsylvania, of June 30, 1885, which is now on passage in the Legislature in addition to requiring one hundred cubic feet per man per minute in non-gaseous mines, provides that: "In a mine where fire-damp has been detected the minimum shall be one hundred and fifty cubic feet per minute for each person employed therein, and as much more in either case as two or more of the mine inspectors may deem requisite."

16. In order to create and maintain a circulation of air through a mine, it is necessary to have at least one inlet and one outlet, and sufficient passages between them for the flow of air, all of sufficient size, and either to rarefy the air-current by heat or to exhaust or pump it out at one end—that is the outlet column—or to compress the air in the inlet column to obtain sufficient pressure.

17. The ventilating pressure necessary for putting air in motion may be obtained by either natural or artificial means. Natural ventilation, on account of the change of the weather, both as regards the direction and force of the wind, and variation in barometer and thermometer, is uncertain and unreliable, particularly in shallow mines, and need not be further referred to here. The artificial means used are generally furnaces and fans or mechanical ventilators.

18. Both furnaces and fans have the same effect in producing ventilation—that is to say, their operation results in altering the density of the air at the return end of the column and in destroying the equilibrium of pressure in the downcast and upcast shafts; and so long as the pressure is maintained by the means applied, the movement of the air will be continued in the direction to where it is most attenuated.

19. The ventilating pressure obtained by a furnace depends mainly upon the amount of heat communicated to the air-current in the upcast, the depth of the shafts, and the area provided for the escape of the heated air; and for the current to be regular, it is necessary that the furnace should be kept constantly at about the same degree of heat. In furnace ventilation the temperature of the air in the downcast is seldom below 40 degrees, and rarely averages more than 200 degrees in the upcast; this gives a pressure of 11·6 at a depth of 200 yards; of 17·4 at 300 yards; and of 23·2 per square foot at 400 yards. (See Table "Showing Pressure of Air in Shafts," in a subsequent chapter.)

20. There is great risk of fire and of explosions in the use of furnaces, but the rapidity with which the use of mechanical appliances has been extended to the ventilation of coal mines of late years shows that eventually the furnace will fall altogether into disuse; as it may well do from the many dangers and inconveniences attending it.

The use of furnaces is forbidden under the 1891 Anthracite Mine Law of Pennsylvania. The section referring to the matter reads as follows:—"It shall not be lawful to use a furnace for the purpose of ventilating any mine wherein explosive gases are generated."

In the mines of Great Britain according to General Rule 2, if the mines are gaseous, furnaces are not prohibited, but the return air is to be carried off clear of the fire by means of a dumb drift.

21. Another objection to the furnace is, that the fumes arising from it eat away the metal casing of the shafts, and injure the wire

. when coal is wound through the upcast. Daglish thoroughly explained this before eting of the North of England Institute igineers in 1859, when he said the injury iot owing to the direct action of the heat e furnace itself, but to the chemical effect . vapours principally in action opposite ntrance of the furnace drift into the —"The sulphur in the coals volatilized ie furnace, combines with a portion of en to form sulphurous acid; this possess- he property of taking up another atom ygen when in contact with moist air, s hydrated sulphuric acid in the upcast , which, diluted with the other shaft , passes down the rope, and as the ig point of hydrated sulphuric acid is ly higher than that of water, the solution ases in strength as it falls down the , and becomes highly concentrated and sive when opposite the furnace drift, and cted to a temperature of probably 300 ees. Water after passing down a deep noist upcast shaft is sensibly acid to the and reddens litmus paper."

. Furnace ventilation cannot in point of omy, successfully compete with mecha- ventilation. As to the cost per horse- r in the air per hour, the late Mr. Morison ed that with furnaces it varied from the of a penny to threepence half-penny, eas with fans the working cost was only a farthing; that is, roughly speaking, working of furnaces cost four cents, and working of fans one-fourth of a cent horse-power. (Transactions of North of and Institute of Engineers, Vol. XIX.)

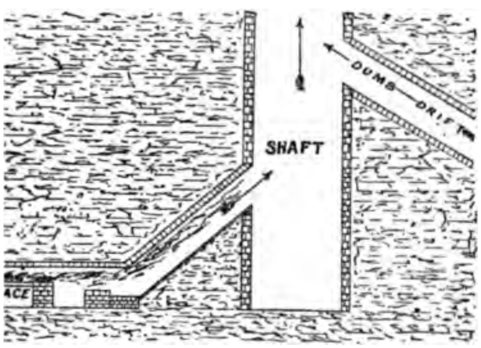


FIG. 1

. The dumb drift which was adopted in ish coal mines more than fifty years ago ensuring safety in furnace ventilation, much reduces the power of the furnace, use it decreases the length of the heated olumn; and there is likewise the addi- l friction in the upcast of the air which feeds the furnace, but which does not circulate through the mine. A furnace probably heats the air up to 300 degrees F., whereas, the temperature of the return air passing up the dumb drift, in all likelihood does not amount to more than 90 degrees; there is, therefore, a loss of the extra heat of the furnace, so far up the shaft, as the air enters it from the dumb drift; the length of the heated column of air being reduced by the vertical distance from the furnace-level to where the dumb drift enters the upcast as shown on Fig. 1, because the main body of air travels along the dumb drift, and not over the furnace. Of course, it is understood that in such a case that the furnace is only supplied by a scale of air simply sufficient to promote combustion.

24. There are two classes of fans, namely, that which forces the air into the mine, and that which exhausts it from the mine; but the latter class is the one chiefly in use. There is a great variety of exhausting fans, each of the respective inventors of which claims for his own some particular merit. It is not intended here to recommend any special fan, but to give general information on the work produced by some of the mechanical ventilators. As to the kind of fan to be adopted at a colliery, there are two points to be considered, the cost of erection and the probable useful effect it will produce. According to the reports of various experimentors, the useful effect of different fans has been ascertained to vary as much as from 30 to 80 per cent. of the power applied. In England, both the Guibal and the Waddle have been favourite fans for a long time, but of late, quick-running ventilators, such as the Capell and Chandler, are being very much adopted.

25. The high-speed Capell fan has recently become extensively used in English and German collieries, and it is stated that at the Prosper No. 1 Colliery, Borbeck, Westphalia, it exhausted 126,480 cubic feet of air per minute with a water-gauge of 10·7 inches, this is the highest water-gauge the writer has known a fan to be worked at.

26. A large number of Guibal fans have been erected at the coal mines of England and on the Continent of Europe. Being a fan of large capacity, it does not require to run at so great a velocity as some of the other fans to exhaust the same volume of air. The makers of this fan, some time back issued the following table to represent practically the duty of the various dimensions at a fair working speed. This, however, varies naturally with the condition of the shafts and

air-ways of the mines, sometimes exceeding the tabulated figures in cases of large air passages, and at other times falling short of them where the currents are hindered by heavy frictional resistance.

Diameter of Ventilator.	Width of Ventilator.	Volume of Air per Minute.	In Cubic Feet.	Water-Gauge in Inches.	Suitable Size of Engine. Dia. of Cylinder.	Suitable Size of Engine. Length of Stroke.
ft.	ft.			ins.	ins.	ins.
10	4	20	000	0·50	6	12
12	4	30	000	0·65	12	12
16	5¼	40	000	0·80	12	18
20	6¼	50	000	1·20	18	18
24	8	70	000	2·00	20	20
30	10	100	000	2·75	24	24
36	12	150	000	3·50	30	33
40	12	200	000	4·25	36	36

27. The Waddle fan has deservedly a good reputation, and is comparatively cheap in erection; it will exhaust a large volume of air, but runs at a higher speed than the Guibal. The following particulars show the results of observations made on the working of one of these fans, 35 feet diameter, at Holmside Colliery, Chester-le-Street, County of Durham.

Revolutions of Fan per Minute.	Volume of Air in cubic feet per Minute.	Water Gauge in inches.	Efficiency per cent.
29·60	83,742	·777	66·7
37·20	108,777	1·082	66·9
50·	140,158	2·07	65·3

As it is a rule in ventilation that the quantity of air in motion is in accordance with the square root of the pressure, or the water-gauge, we may apply it to the above results, thus:—

The square root of ·777=·881
The square root of 1·082=1·04
The square root of 2·07=1·439

then if ·881 : 83742 :: 1·04 ought to give 98·853, and 1·439 ought to give 136,782, which figures are different to the actual quantities given, but the discrepancies might be occasioned by the reading of the water-gauge in the first quantity being put a little too high. Although here the quantities do not come out mathematically true the law of ventilation mentioned is practically maintained.

(To be continued.)

ANSWERS TO QUESTIONS

No. 3 Set—In No. 26, Vol. II.

ELEMENTARY.

CLEAVAGE, FACE, END.

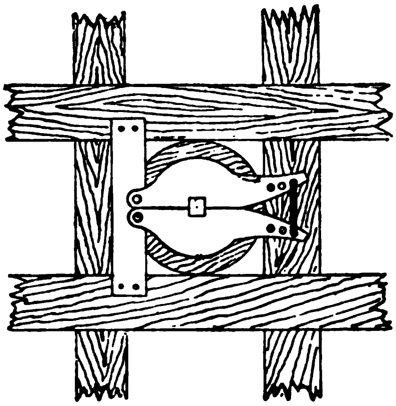
Question 1.—What is meant by cleavage, face, end ?

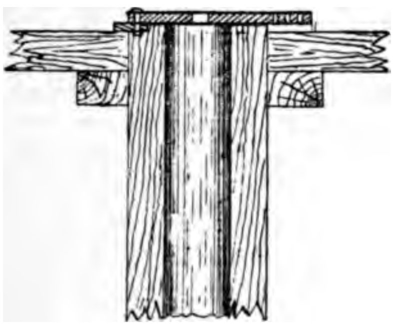
Answer.—Nearly all rocks have joints which traverse in two directions, generally at right angles to each other, and which divide them into blocks of greater or less dimensions. These cracks or joints are termed cleavages, and are a help in blasting operations; they assist the working of coal, and the direction of the working places are frequently determined and guided by them. The vertical thickness of coal is made up of layers, or thin laminæ, which run parallel to the beds. At right angles to these lines of lamination are sets of joints, at right angles to each other, one of which is very clear and distinct, producing a smooth vertical section, and is termed the "face," to which the name "cleat," or "slyne," is applied by miners. Sometimes, however, the name (face) is applied to the front part of an excavation or bank. In some seams the "cleat" is very indistinct, perhaps more so in hard than in soft seams. The term "end" is applied to the end of the facings or cleats, and is at a right angle to the "face." JOSEPH WHEATCROFT.

BORING WITH RIGID RODS.

Question 2.—When boring with rigid rods how is the borehole kept vertical, and what arrangements are made for changing the rods? Give sketches.

Answer.—In order to keep the borehole vertical when boring with rigid rods a guide-tube is used, and great care should be taken in fixing the same. It consists of a cylindrical piece of wood, about 12 inches in diameter and 6 feet in length, with a hole bored through it from end to end, of the same diameter as the intended borehole. This is securely fixed at the top of the borehole in a strong wooden frame and provided with a pair of iron shutters to prevent anything from falling down. In some cases, however, a scaffold is erected about 30 inches high, and a metal pipe, the same size as the intended borehole and about 4 feet long, is passed through the scaffold with





its flange 2 inches above it, the pipe being truly plumbed to get it perpendicular and then wedged. When rods are to be changed or tools cleaned, the brace-head is unscrewed and a lifting-dog is used, which consists of an iron clawhook, at the top of which is a ring for attaching to the windlass rope. When the rods are ready to be raised the clawhook is placed under their highest joint, hauled to the top of the headgear by the windlass, and are then taken up by means of a nipping fork placed below the next joint lower, which appears at the top of the borehole. The joint is then unscrewed by the key, the rods released and laid aside, and the lifting-dogs detached and lowered to repeat the operation, until all the rods are withdrawn and changed as required. Instead of having a separate tool for the support of the rods while unscrewing, a piece may be cut out of the shutters, as shown in sketch, so that they will prevent a joint from passing through; but the hole is large enough for the ordinary diameter of the rods. The shutters may be opened outward as required.

JOSEPH WHEATCROFT.

ADVANCED.

TRANSMISSION OF POWER.

Question 3.—Describe the various methods of transmitting power adopted in mining operations, and discuss the efficiency and adaptibility of each.

Answer.—The various methods adopted for transmitting power in mining operations are rods, belting, ropes, steam, compressed air, electricity, and water.

(1) RODS. The transmission of power by rigid rods is adopted in all engines by the use of the connecting rods. This method is only adopted for short horizontal distances, but it may be employed for long vertical distances, in which case the weight of the rods is no detriment to working. Almost the only class of work to which long lengths of rods are applied is pumping, for which it is very efficient.

(2) BELTING. This method is adopted instead of intermediate spur wheels for short distances, as adopted to driving fans, jigger screens, saw mills, etc.

(3) ROPES. For transmission underground this is the most efficient method at present in use. An endless wire rope is coiled round the driving wheel of the engine and is passed down the shaft to a return wheel, from which power may be taken for various kinds of work. The work to which it is usually applied is haulage, several districts receiving motion by means of other ropes and wheels from the return wheel of the driving rope. In some instances where only one road is worked the one rope passes along the haulage plane to a return wheel at the inbye end and is applied directly to its work.

(4) STEAM. This is perhaps the most familiar of all methods of transmitting power over short distances, as from the boilers to the various engines on the surface. Several years ago it was a common occurrence for boilers to be situated underground, so as to be near the engines for which they generated steam, but this is not countenanced in modern times, by reason of the great danger of having large fires underground, and when steam engines are situated underground the steam is transmitted down the shaft in pipes. The disadvantages of this system are great loss of power through condensation and leaking joints and the exhaust steam has an injurious effect upon the roof of the mine.

(5) Compressed Air. Both this and the following method of transmitting power have come into more general use of recent years. Compressed air is a very convenient method of transmitting power, and possesses various advantages over steam, especially for work which is required at the face workings. It is absolutely safe and the exhaust assists the ventilation. From an economic point of view it is, however, unsuitable for general work, as the percentage of useful effect is so low.

(6) Electricity. This method although in its infancy is making rapid strides and will no doubt become generally used in mining operations when more perfectly applied. It gives great facility for conducting underground, and for long distances it is economical, though it is not applicable to fiery mines.

(7) Water. Water has recently been employed to transmit power in pumping operations with good results. It depends for its action on the incompressibility of water. The power is applied at one end of a series of pipes containing water and immediately transmits it to the other. Ed.

FIRST-CLASS.

MATHER AND PLATT'S BORING MACHINE.

Question 4.—Describe, with sketches, the Mather & Platt method of boring, and give details of how the rotary motion of the cutting tool is obtained, and how a shock is prevented in the steam piston employed for lifting the cutting tool sufficiently high to give the stroke.

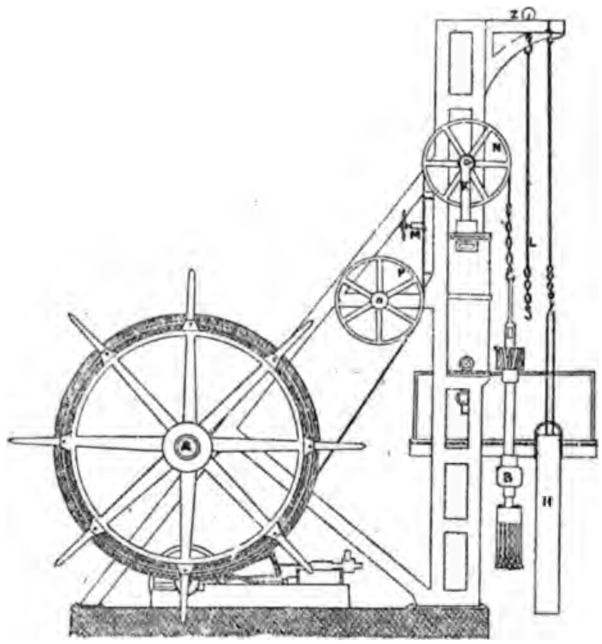


Fig. 1.

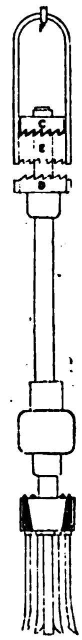


Fig. 2.

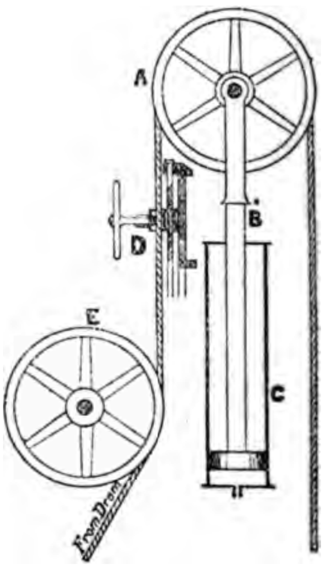


Fig. 3.

Answer.—The Mather & Platt method of boring is seen fully in the accompanying sketches. The following is a description of how the arrangement works its way through the strata. Instead of the boring tool and the shell pump being attached to heavy rigid rods they are suspended in their turn, as desired, to a flat rope about $\frac{1}{2}$ inch thick and $4\frac{1}{2}$ inches broad. This rope is wound upon a winding drum (A, fig. 1), which is 10 feet diameter, and is capable of holding 3,000 feet of rope. This drum is worked by a steam engine with a reversing motion, by which one person can regulate the operation with great ease. This engine and drum are for the purpose of raising and lowering the boring tools and shell pump into the bore-hole. From this drum the flat rope passes under a guide pulley (P), through a clam (M), and then over the drum (N), which is forked on the end of the piston rod (K), and so on to the end which receives the boring tool (B). As soon as the boring tool is lowered to the bottom of the hole the rope is clamped and made fast at (M). The percussive motion of the cutter is produced by means of a steam

cylinder (fig. 3), which is fitted with a piston of 15 inches diameter, having a rod of cast-iron, 7 inches square, branching off to a fork in which there is a pulley (A) about 3 feet in diameter, of sufficient breadth for the rope to pass over, and with flanges to keep it in its place. As the boring head and piston will both fall by their own weight when the steam is shut off and the exhaust valve opened, the steam is admitted only at the bottom of the cylinder. The exhaust port is a few inches higher than the steam port, so that there is always an elastic cushion of steam of that thickness for the piston to fall upon. The shock in the steam piston is also prevented by an elastic cushion of steam a few inches in thickness. The rotary motion of the bar is as follows:—When the bar strikes the rock the rope is allowed to be a little slack. This causes the bush, to which the bow (F, fig. 2) is attached, to slide an inch or two down the bar, until it is liberated from the teeth of the top collar or ratchet (c), and fits itself into the teeth of the bottom one. The teeth of the latter being half-a-tooth out of a direct line with the former the bush must twist slightly on the bar before the teeth on the underside of it fit completely into the lower collar or ratchet. This action brings the cutter into the required position and the whole weight of the bar is then taken up by the rope. The latter being flat will naturally assume its straight position, and in untwisting takes the cutter round with it. This takes place at every blow made by the tool and thus by the percussive and rotary motion it works its way effectively and successfully through the strata. The shell pump (H) is a cylinder of cast-iron, about 8 feet long, a little less in diameter than the size of the hole. At the bottom there is a clack opening upwards, similar in action to that in ordinary pumps. Above this clack there is a bucket similar to that in the common lift pump, with an india-rubber clack on the top side. When the bore-hole needs cleaning out this shell pump is lowered and the debris is pumped into it by lowering and raising the bucket about three times; it is then brought to the surface and emptied. In conclusion it would be as well to mention that the boring tool and pump can be let down and drawn up by the engine as quickly as the cages in a winding shaft. GEORGE DAYKIN.

METHOD OF WORKING SEAMS.

Question 5.—How would you work three seams of coal lying 20 feet from each other, the first seam being 5 feet thick, the middle seam 5 feet 6 inches thick, and the bottom seam 4 feet 6 inches thick.

Answer.—Before deciding how to work these three seams of coal one very important thing is to be taken into consideration, viz.: The inclination of the seams and in what direction they incline. In the first place I would have the shaft sunk down to the 4 feet 6 inches or bottom seam. From this point I would drive drifts or inclines through the measures into the two upper seams, as this arrangement would enable all the coals to be wound from one level. When I had reached the seams I would then decide how to work them. Supposing the seams lay on the rise from the shaft I would work the top seam on the advancing longwall system, and the other two on the bord and pillar system. If the seams dip from the shaft I would work them right out to the boundary, and then work all three back on the retreating longwall system, thus leaving all the goaf behind and getting rid of all the disadvantages which take place while seams are being worked in close proximity. In both the above cases I would employ a larger number of men in the top seam so as to work it out first, thus reserving the lower seams until the last. If the bottom seams are worked out first, the working of the upper seam is attended with much danger to the workmen and expense to the owners. It has been known that when two seams have been opened out together and worked parallel with each other the result was that the bottom seam went on alright, but what was the result in the top seam? It was very dangerous for the workmen, and it caused the owners a heavy loss of timber, etc. Everything was on the move—the floor being full of cracks and fissures, making the roadway into the top seam impossible to keep open, and finally, nearly losing the seam altogether. From the above it will be seen that the best plan is to advance or lead "ahead" with the higher or top seams and, if possible, leave the bottom seams untouched until the last, as they then act as a good foundation for the strata above.

GEORGE DAYKIN.

COMPETITION QUESTIONS.

No. 6 SET.

To the sender of the best set of Original Answers in each Stage will be awarded the following:—

Elementary 2s. 6d., Advanced 3s. 6d., First-Class 4s. 6d.

A Competitor may only answer one Stage in each issue, though a different Stage may be taken in another issue. The best answer to each question will be published with the sender's name and address.

1.—All envelopes must be marked "COMPETITION."

2.—To be written on separate sheets of paper with name attached, and on one side of the paper only. Sketches to be in ink on *unruled* paper.

3.—Correct name and postal address must be sent

4.—They must reach us by January 11th, 1895.

5.—The Editor's decision as to winners to be final.

ELEMENTARY

Question 1.—How would you determine the following preliminary operations to sinking, viz.:—position, form, size, and making out of shaft?

ADVANCED.

Question 2.—Show by sketches the method of timbering a $5\frac{1}{2}$ yard bord with a bad roof, and of timbering and pillaring (the face of a gateway and two adjoining gateways, for a distance of 10 yards back) in longwall workings.

FIRST-CLASS.

Question 3.—Draw a plan showing how you would lay out the workings of a colliery for 175 hewers in each shift (a) Give the number of men in each district; (b) State the quantity of air in each split and indicate its course by arrows; (c) Show the position of all stoppings, crossing doors, and regulators; (d) Show main ways and landings.

NOTE.—One half the output to be from bord and pillar, and the other from longwall workings.

EDITORIAL CHAT.

We have pleasure in introducing our Special Number to our readers and hope the venture will be appreciated. We are partly fulfilling the desire of many students who wish us to enlarge the paper and increase the price, but so far we have only decided to do this on the present occasion.

We have been frequently asked questions *re* the Colliery Managers' Examinations, and have published a few details and sundry hints in this number which intending candidates will find worthy of note.

We have also published an abbreviated description of the British coalfields to accompany the map, and the first of the series of articles on "Mine Ventilation made Easy," by W. Fairley, F.G.S., which will be continued in subsequent issues.—ED.

CORRESPONDENCE.

We will publish a reasonable amount of correspondence per issue, but subject to the following conditions:—

To be written on one side of the paper only.

Envelopes to be marked "Correspondence."

Name and address of sender must accompany such correspondence as a sign of good faith but the writer may assume a *Nom-de-plume* to be published if he so desires.

Correspondence must not be enclosed with Competition Answers.

The Editor will not hold himself responsible for any correspondence, nor will the publishing of it affirm that we hold the same views as the writer.

WHAT IS A M.E. AND A C.E.?—ANSWER.

Sir,—In answer to the above queries by El Diabilo, it is a difficult matter to say what a M.E. really is. Many men put M.E. after their names evidently to stand for mining engineer, but anyone may call himself a mining engineer. As I understand it, a mining engineer is a man who is capable of valuing a colliery or coal lease, of working out the various intricate problems which the intermission of faults produce, and a general superior knowledge of all colliery matters. A colliery manager may not be a mining engineer. The term is generally applied to men who have served apprenticeship at a mining engineer's office. A C.E. is a civil engineer, or one who plans railways, docks, etc.—T.D.

VENTILATION—CRITICISM OF COMPETITION QUESTION.

Sir,—With regard to the error in connection with the question on ventilation, pointed out by Mr. Ralph Anderson, I beg to give the following explanation:—The error was caused by placing the relative velocities in their wrong places, and after working the question out by using "Atkinson's Formulæ," the result differs from the answer given by myself and also that given by Mr. Anderson, the result being as follows:—

(*a*) Airway		(*b*) Airway
$p = \frac{S V^2}{a}$	:	$p = \frac{S V^2}{a}$
$p = \frac{24 \times 25^2}{36}$	:	$p = \frac{20 \times 36^2}{25}$
$p = 416$	:	$p = 1036$

Hence the relative pressures are as 416 to 1036, thus to produce the same quantity of air in the 5 feet airway it would require—

$$= \frac{1 \times 1036}{416} = 2{\cdot}49 \text{ in. water-gauge.}$$

A rule to find the pressure required in airways having different areas is given in "Wardle's Practical Coal Mining," as follows:—

"Pressures vary inversely as their areas cubed."

$$\therefore \frac{36 \times 36 \times 36}{25 \times 25 \times 25} = \frac{46656}{15625} = \frac{1 \times 46656}{15625} = 2{\cdot}98 \text{ W. G.}$$

Also by applying the rule "that the pressure varies inversely as the area" to the answer given by Mr. Anderson, the result will be similar to those already given:—

$$\frac{1{\cdot}728 \times 36}{25} = 2{\cdot}49 \text{ in. water-gauge.}$$

I should like other students to give their opinions upon this question, especially as to which rule they deem most exact. MYLES BROWN.

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MINING
A JOURNAL DEVOTED TO THE

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4. Vol. III.

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CONTENTS

EASY LESSONS ON MINE SURVEYING

For Beginners

Continued in N...

LEVELLING.

VERTICAL distances ... mined practically ... trigonometrically and ...

By the trigonometrical ... length of the line joining the ... vation, or the horizontal ... and the angle between ... taken with an instrument. ... height of the two objects ... by trigonometry, or by ... measurement. For levelling ... clinometer, dial, theodolite ... instrument having a ver... may be used. Where ... required observations ... clinometer, as this is a ... ment and is easy to ... form of clinometer is ... as ... ured by ... two p... ot ru... for ... e by ... leve... ne i...

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which is provided with an eye piece at one end and with an object glass at the other; it also contains a diaphragm which is provided with two vertical wires and one horizontal cross wire. A small cross spirit level is also attached to facilitate the adjustment. The telescope is provided with a focussing arrangement worked by a large milled head screw. If the difference in level of two points A and B (fig. 94) is required, not a considerable distance apart, the instrument is set up at any intermediate point that may be convenient for seeing both points of observation. The telescope is made to assume a horizontal position by means of the adjusting screws on the lower part of the instrument, and a sight is taken towards a graduated staff which is held at A. The staff is held in a perfectly vertical position, and the height where the cross hair appears to cut the staff is read off; the markings of the staft being such that the height can be read through the telescope. The staff is then held at B, the telescope is turned round, and the point where the cross hair cuts the staff is again read off. To ascertain the difference in level of the two points, the less of the two readings is subtracted from the greater. Thus the reading at A is 11·76 and at B 9·26, therefore the difference in level between these two points is 2·5.

If a section of the ground between the points A and B was required, it would be necessary to take intermediate sights as shown at *a b c d* and *e*, where any change in the inclination occurs. Horizontal measurements must also be taken so as to fix the position of the sights. The following is a method of recording the observations :—

LEVELS OF GROUND FROM A TO B. (FIG. 94.)

Distance in Feet	Sights. Back	Inter	Fore	Rise	Fall	Reduced Levels	Remarks.
0	11·76	..	..	..	..	10·00	From A
7·3	..	10·92	..	·84	..	10·84	*a*
20·5	...	5·78	..	5·14	..	15·98	*b*
26·2	..	4·96	..	·82	..	16·80	*c*
35·5	...	5·20	..	..	·24	16·56	*d*
45·8	..	8·90	..	..	3·70	12·86	*e*
54·8	..	..	9·26	..	·36	12·50	To B
	11·76			6·80	4·30		
	9·26			4·30			
	2·5	Difference		2·5			

and 12·5—10 = 2·5 the reduced rise.

The first sight to A is a backsight and is booked accordingly. The next sights to *a b c d* and *e* are booked as intermediate sights and the sight to B is termed the foresight. The first four columns denoting the distances and the sight readings, and also the last column of remarks are booked while the work is proceeding, and the other three columns are worked out and the totals found after the work is completed. The rise and fall calculations are made by simply taking the difference between each sight and the one preceding. When the reading is less than that of the preceding sight the difference is booked as a fall. For example the first sight is 11·76 and the second 10·92, then the second sight has a rise of 11·76 — 10·92 = ·84. Again the sight to *d* is 5·20 and to *e* is 8·90, therefore there is a fall from *d* to *e* of 8·90 — 5·20 = 3·70.

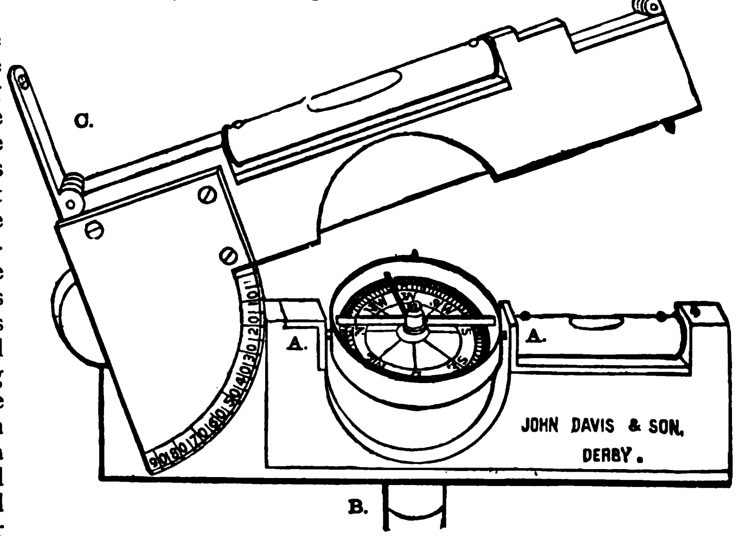

FIG. 92.

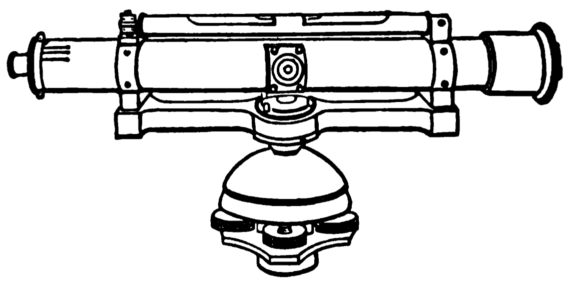

FIG. 93.

Before proceeding to fill in the column of reduced levels, a datum line is chosen 10, 20

›o feet below the first reading, and the :ed levels are calculated to this datum line. reason for this is that the first observation resight is not necessarily the lowest point ıe series of levels, as happens to be the with those recorded above, and if a m line was adopted at this level some :vations might fall below the datum line, would require a minus sign in the :ed levels. It is therefore expedient to t a datum line 10, 20 or even 100 feet v the first observation as the circum- :es require.

the levels recorded a datum line 10 feet v the first foresight is adopted, so that ırst sight would be booked in the reduced column as 10. The second sight to *a* ı rise of ·84 as previously calculated, fore the reduced level for this point is ·84 = 10·84. For the next point the ;·14 is added to the 10·84, and the next luced in a similar manner. To ascertain educed level for the point *d* however the 24 is subtracted from the reduced level e previous sight, and the next two sights reated in the same manner.

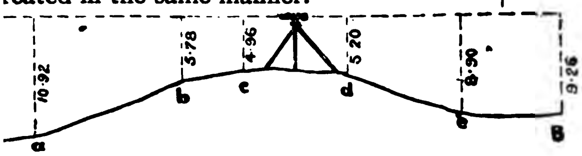

FIG. 94.

check may be obtained on the calcula- by taking the difference of the foresight backsight, of the falls and rises, and of ssumed datum and the reduced level of ıst observation. These three remainders ld be equal.

there are several foresights and back- s the difference of the totals are taken in ıilar manner.

(*To be continued.*)

IETHODS OF WORKING COAL IMS IN CLOSE PROXIMITY.

BY JOSEPH CARTER.

E following are a few of the evil effects produced by the working of the lower of seams in advance of the top one when distance between is only short, My :iences have been with mines from 20 to ırds apart.

ıe effects may be enumerated as follows, are caused when working longwall or ving pillars in bord and pillar work:—

1.—Dislocation of the intervening strata, causing (when working fiery mines) the gas made in the mine below to issue through the broken crevices into the mine above, and besides this, props and chocks, &c., in the top mine are loosened in the vicinity of the excavations made below, causing great trouble and danger.

2.—The coal becomes more difficult to get and requires a greater amount of explosive to bring it down.

Under such circumstances the coal was called sunken coal, and could easily be told by the collier when working, owing to their changed nature. I have paid from 6d. to 9d. per ton to the collier above the current prices

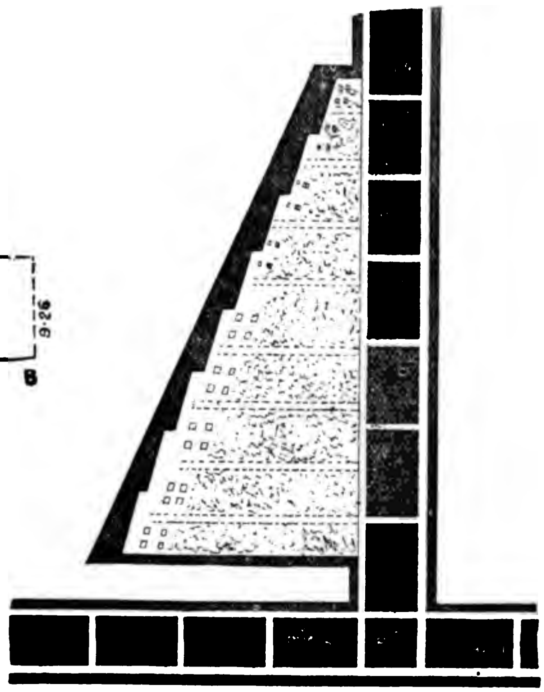

FIG. 1.

in the mine for working this coal. The sketch (fig. 1) shows a district we were opening out in the top mine, and in the mine below the same operations were going on but a little in advance, and in all cases when coal is worked out, there must occasionally be a sinking of the roof on the packs, and a falling of the roof in the wastes between the packs when all is not packed, as in the case mentioned. When this weighting and falling have taken place, not unfrequently the difficulties and dangers in the top mine are great, because I have seen props, chocks, &c., sunk so as to leave the roof without any

support (see fig. 2), and before these could be put right the places have fallen. This happened so frequently and caused so much trouble

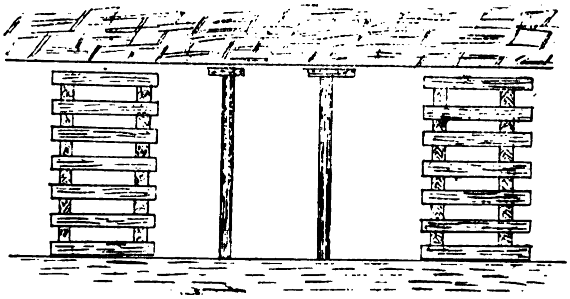

FIG. 2

that we abandoned the longwall system and proceeded in bord and pillar to the boundary. Fig. 3 shows the effect produced at times when the mine below has even been worked in bord and pillar, and the pillars have been taken out in advance of the top mine. The intervening strata sinks and causes the coal to sink and separate from the roof as shown. I have seen the coal one inch away from the roof for a good distance along some of the roadways in the mine. It was with great difficulty I could get men to work such coal, and then it was only at a great expense. Practical experience teaches us that it is better to

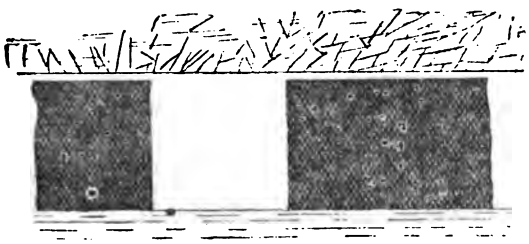

FIG. 3

work the top seam in advance of the bottom one, because it is safer, costs less, and a greater quantity of coal per man in the upper seam is sent out. We had a proof of this when we had three districts cut to the boundary in bord and pillar, and the pillars worked out in advance of the bottom mine. The difference between the two methods was very great in more ways than one. Thus in several instances I took out the cost in actual figures, and have known it to increase them from 1s. to 1s. 3d. per ton more by taking everything into account. Some of our readers might ask why do they work them so. The only reason I can see is that the deep seam is usually of a better quality, and consequently of greater demand at times, it also sells for a better price in the market, and very often the cost of production is less than in the top seam. Therefore the poorer class of coal is but worked indifferently without fully looking into the result produced by such methods. I think these remarks will not be out of place here as they are taken from practical experience of such mines, and the cases thus pointed out are such as actually took place from time to time, and as such I have recorded the effects. I have also taken out at times the cost, loss of coal per man, &c., and then I always found it to be very great, and what was gained in the one case was lost in the other, besides the greater danger to contend with in the working of the upper seam.

COMPETITION QUESTIONS.

No. 7 SET.

TO the sender of the best set of Original Answers in each Stage will be awarded the following:—

Elementary 2s. 6d., Advanced 3s. 6d., First-Class 4s. 6d.

A Competitor may only answer one Stage in each issue, though a different Stage may be taken in another issue. The best answer to each question will be published with the sender's name and address.

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2.—To be written on separate sheets of paper with name attached, and on one side of the paper only. Sketches to be in ink on *unruled* paper.
3.—Correct name and postal address must be sent.
4.—They must reach us by January 25th, 1895.
5.—The Editor's decision as to winners to be final.

ELEMENTARY.

Question 1.—What are faults? What different kinds of faults are there, how is the direction of the throw usually arrived at, and what indications does the seam in proximity to a fault give? What is meant by the hade of the fault, and what is the usual angle of the hade?

ADVANCED.

Question 2.—How is the sinking of a shaft conducted through quicksand? Give sketches.

FIRST-CLASS.

Question 3.—A coalfield of 500 acres has been fitted, and it is desirable to have a large output from the only workable seam, 220 yards deep, as soon as possible. The coal is 6 feet thick and is only suitable for working stoop and room. The dip is 1 in 8. Sketch and describe how you would lay out the workings in such a manner that within 18 months you would have three sets of colliers at work, viz.:—

(*a*) Winning out levels and headings and forming large blocks or areas of coal.
(*b*) Splitting such blocks into 16 or 18 yard pillars.
(*c*) Taking out the 16 or 18 yard pillars.

The seam is fiery and particular attention will be required to lay out the airways so that the stoopers (who only work with safety lamps) shall have the air from the other sections, and that no others use it after airing the pillar workings. Show the course of the ventilation and the accessories for same.

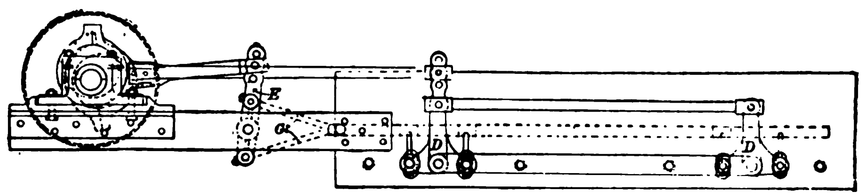
BANKING ARRANGEMENTS.

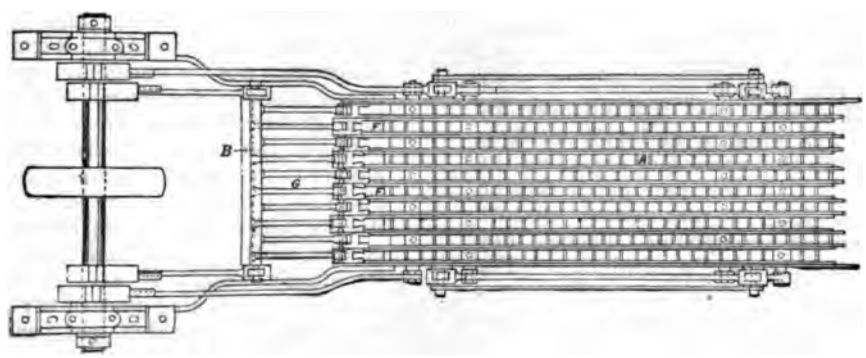
CHAMBER'S PATENT SHAKER SCREEN.

THE accompanying illustrations show plan and side elevation of Chamber's Patent Screen as manufactured by Messrs. Bradley and Co., Wakefield. It is a very simple and complete arrangement having a series of meshed bars which have a vertical and lateral movement imparted to them through rods and levers from eccentrics on a revolving shaft, the bars are carried on pins rocking in inverted steps provided in the bars. The motion of each bar is in reciprocation of each bar on either side and rises, moves forward, falls, and recedes as the alternate one falls, recedes, rises, and moves forward; by this arrangement the coal is gradually carried over the meshes to the travelling bands. The construction and mode of working will be clearly understood from the illustrations.

The following are the advantages claimed for it:—Large capacity, 4 tons per minute being effectively separated, therefore saving bank room, distance in tramming, reduction of labour, multiplication of screens, &c. Regular delivery on to the picking bands. Saving of breakage, only sufficient movement being imparted so as to cause the small to separate from the large and fall through the meshes. The material is carried horizontally or at a very slight gradient, thereby saving height in bank above wagons. The bars can be any length to suit wagons, position of picking bands, tipplers, &c., and if necessary the coal can be picked on the screen. Any number of meshes can be used in tiers for screening into various sizes, all working from the same set of levers with adjustable throw to suit material, each tier only occuping a space of 12 inch in height. The bars can be taken out and others substituted for a different sized coal in a few minutes. Few wearing parts and these all removed from contact with the coal and dust. Not liable to get out of order and easily repaired. It is perfectly noiseless in operation. No vibration to cause heapstead to rock. Very little power required for driving.

The screen can be seen working at the Denaby and Cadeby Main Collieries.





ANSWERS TO CORRESPONDENTS.

RECEIVED.—James Beswick, H. Fletcher, R. Tinsley, R. Alderson. T. C. Aspinall. D. Cunningham,

WAKEFIELD.—Will write you.

R. W.—Thanks. We have been complimented by one of H.M.I.M. for the practical nature of our paper in general.

COMPETITION.—(1) It would be obviously unfair for us to suggest the subject of an essay for a competitor, but if he will suggest a subject we will tell him whether we deem it suitable or not. (2) Yes. Give as many illustrations to your answers and essays as you think fit; one illustration is often better than a page of writing.

THE ATMOSPHERE.

By MYLES BROWN.

BY the term "atmosphere," is meant that ocean of air which surrounds or envelopes our globe and at the bottom of which we live. Nothing is so essential or necessary to life as an efficient supply of pure air; instances have been known where men have been entombed in mines for many days without any food their only substance being air, and yet they have survived; but had the supply of air been cut off they would have perished immediately. The composition of the atmosphere is much the same in all parts of the world. Samples of air have been taken from lofty mountains, the plains of Egypt, from London, Paris and various other places, and when analysed, have been found to contain the usual proportion of oxygen and nitrogen. The variations which do exist, being chiefly due to the production of deleterious gases, by manufacturing and chemical works. The atmosphere consists chiefly of a mixture of two gases, namely—oxygen and nitrogen, yet, it also contains carbon dioxide or carbonic acid gas, in the ratio of 4 in 10,000 parts, also a slight trace of ammonia gas may be detected, but in only very small quantities, namely—1 in 1,000,000 parts. The atmosphere also contains water vapour, the quantity depending on the state of the weather; hence the composition of the atmosphere in round numbers may be stated as—oxygen $\frac{1}{5}$th, nitrogen $\frac{4}{5}$ths, or to be more accurate 21% oxygen, and 79% nitrogen by volume, and 23% oxygen, and 77% nitrogen by weight. An important fact regarding the atmosphere, is that the two gases oxygen and nitrogen form a mechanical mixture not a chemical compound, hence they are mixed not chemically combined. For examples of mechanical mixtures, place sugar and sand in the same vessel, thus they would form a mixture; or, if a stream or river be observed after a heavy downfall of rain, the dark colour of the water will be noticed, which is owing to the water being mixed with sedimentary material which has been collected by the stream or river during its rapid movement to the sea. If a quantity of this water was placed in a vessel and then allowed to stand, it would be seen that the sand and soil would sink to the bottom, and by so doing would make the water much clearer, thus proving that it was a mechanical mixture. For examples of chemical composition take the gases most generally met with in mines, namely—carbon dioxide, CO_2; and carburetted hydrogen, CH_4 The two gases oxygen and nitrogen have neither colour, taste or smell, and are in these respects like air itself, but their respective properties are very dissimilar.

OXYGEN is the chief supporter of life and combustion, to support life it must be inhaled in its elementary and uncombined state; all matter which is combustible burns much more vividly in oxygen than in air, for example—iron wire will burn in an atmosphere of pure oxygen. Oxygen is a very active gas, it will combine with every known element except fluorine; it is the most abundant substance in nature, forming 89% of the water, 23% of the air, and about $\frac{1}{3}$rd of the solid part of the globe, being found as a constituent of such minerals as lime, quartz, clay, as well as in combination with various metals as oxides; it is soluble in water, and it is owing to this important feature that fishes have no need of coming to the surface for the supply of oxygen with which to aerate their blood. The specific gravity of oxygen is 1·105 or about $1\frac{1}{10}$th the weight of air, its atomic weight is 16.

NITROGEN differs entirely from oxygen, it being a very inert gas; it dilutes the oxygen of the air, thus making it fit to be inhaled. Nitrogen does not support life and combustion if breathed in its pure state without being mixed with oxygen; it causes death by suffocation not by poisoning, this being due to the absence of oxygen. Nitrogen has very little chemical affinity for any substance, its action in the atmosphere is similar to water among liquids which is chiefly used to dilute and render fit for use any substance which by itself would be too active; its specific gravity is ·971, a little lighter than the weight of air; its atomic weight is 14. A man inhales about $\frac{1}{5}$th of a cubic foot of air per minute, which equals 12 cubic feet per hour; when exhaled it consists of a large percentage of unchanged air, and a small percentage of pure nitrogen and carbon dioxide. The atmosphere as before-mentioned consists of $\frac{1}{2500}$th part or ·04 % of carbon dioxide, but this is largely augmented when large numbers of persons are congregated together unless there is a good current of air. It is said that 2% of carbon dioxide in the air produces discomfort, 5% produces faintness, and 10% produces fatal results. Air that is exhaled from the lungs contains 5% more carbon

dioxide than that which is inhaled; this is owing to the chemical union of waste matter with the oxygen of the air. Nevertheless, carbon dioxide (with water) is the essential element in the vegetable kingdom. Plants could not live and grow in an atmosphere consisting only of oxygen and nitrogen. Waste is not known in the natural kingdom as all matter is indestructible. An important phenomenon of nature is here manifested, namely—human beings and animals, inhale oxygen and exhale carbon dioxide, which if it remained in the atmosphere would be detrimental to health and finally cause death; but the vegetation withdraws the carbon dioxide from the atmosphere for the purpose of building up and supporting its structure and gives off oxygen.

Physical Properties of Air.—Air is an elastic fluid, and therefore subject to Boyle's law:—The volume of a gas varies inversely as the pressure; the higher regions of the atmosphere are much more attenuated than those near the surface, the air becomes thinner and lighter the further we go from the earth's surface. If the density of the air had been stationary, we could have calculated the height of the atmosphere, but this is not the case; hence no definite conclusion can be come to as to the height of the atmosphere, as air is elastic and subject to Boyle's law as abovementioned. Prof. Lewes states that the atmosphere extends to a height of at least 45 miles from its surface, but there is much diversity of opinion regarding this subject, some authorities stating that on observing the passage of meteorites through the upper regions of the atmosphere, that it is sensible in its effects at a height of 200 miles. Air being elastic and having weight, causes the lower strata of air to be compressed, thus making the air near the surface of the earth very dense owing to supporting the superincumbent atmosphere.

Air is Impenetrable—that is, if any space be filled with air, no other matter can occupy that space until the air is first displaced.

Air possesses the property of Inertia—that is, it will remain at rest or in the same state of motion until acted upon by some force or resistance; a calm in the atmosphere is the result of equal pressure in all directions. There is always a pressure in every direction exerted by the atmosphere; this pressure arises from the mere weight of the superincumbent air, and amounts to nearly one ton per square foot, or to be more exact 14·7lbs. per square inch. If the pressure on one side be reduced, the ordinary pressure on the other side forces the air towards the lesser pressure, thus giving rise to what is termed a wind. This reduction of pressure is brought about by the heat given off by the sun.

(To be continued).

ANSWERS TO QUESTIONS

No. 4 Set—In No. 1, Vol. III.

ELEMENTARY.

DESCRIPTION OF UNDERGROUND TOOLS.

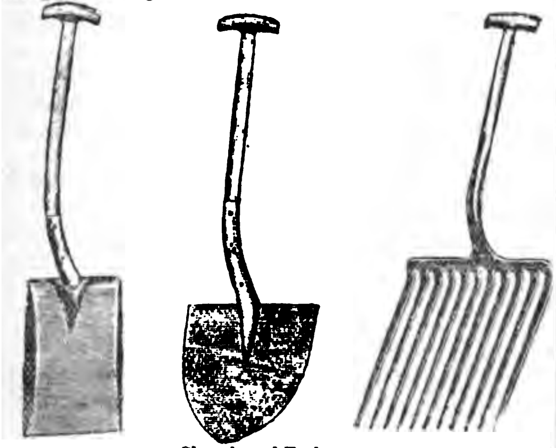
Question 1.—Give a description with dimensions of the various tools used underground.

Answer.—The tools used in coal mining are few in number and generally of a simple character. They consist of picks, shovels, hammers, wedges, borers, and a few others. The following is a description of the most useful, or the most common forms at the present date:—

Various forms of Picks showing the Hardy Patent Shaft.

Picks.—These are also known as hacks and slitters. They vary much in different districts and according to the special purposes to which they are applied. A pick consists of a blade or head, made of iron or steel, and a shaft or handle made of wood. The blade varies in weight from 2 to 8lbs., according to the nature of the work to which it is applied. In the middle of the blade there is a hole or eye into which the shaft is fitted; from the eye the blade, which is generally of a square pyramid form, tapers on each side to a point. The amount of taper depends upon the hardness of the coal or stone upon which it has to be used. For instance, if required for work in hard stone the taper is short; if in soft stone or coal the taper is much longer and thinner. The blade is sometimes made

so as to be at right angles to the shaft—this form is adopted where a long reach is required and for getting in nooks and corners. Sometimes, however, the blade is curved inwards to the shaft; a more common form is the anchor shape. The handle or shaft of a pick is usually made from 30 to 36 inches long, and of an oval section, suitable for a man's grasp. At the head of the shaft, where it is fitted into the eye of the blade, its section is made a little larger, and it is firmly secured to the latter by means of iron wedges driven in at the top. In this way one blade and one shaft constitute a pick. A pick which has of recent years come into general use is the Hardy Patent Pick, only one shaft being required as the heads are interchangeable, the change being effected in a few seconds by a simple arrangement.



Shovels and Forks.

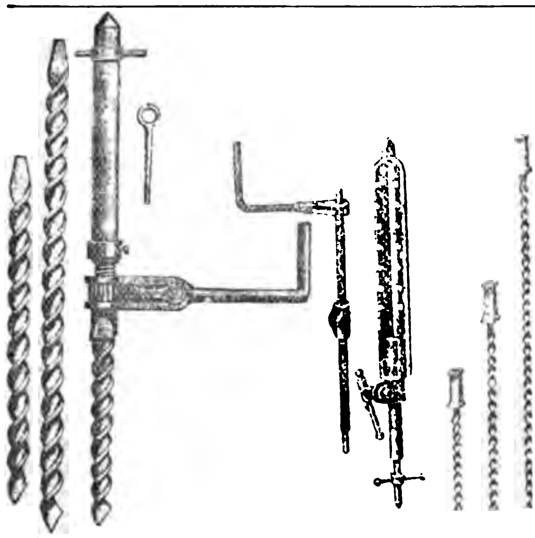
SHOVELS.—A shovel consists of an iron or steel plate with a handle of wood. The plate varies in form in various districts and for the different work for which it is used. Its weight varies from 3 to 5lbs., its length is about 16 inches, and breadth from 10 to 14 inches—usually being larger for coal than for stone. The handle varies in length from 30 to 48 inches, and has a cross-piece or hilt at the opposite end to the plate, set at a right angle to the handle. In some districts forks are used instead of shovels for filling coal, thus screening the coal at the same time.

HAMMERS.—These are termed sledges and malls, and are used in mining for several purposes, such as driving wedges into coal and stone, breaking large pieces of stone, striking drills in boring shot holes, and setting timber. The head of a hammer is usually made of iron or steel, and when made of iron the end or striking face is steeled. In the centre of the head there is a hole or eye for the reception of the handle or shaft, which is made of wood and suitable in shape for the grip of the hands. The head is made from 4 to 9 inches in length, and 2 to 3 inches in square section, with the edges bevelled to reduce the weight and also when striking drills to avoid injuring the hand of the person holding the same; its weight is from 5 to 10lbs. The shaft or handle varies in length from 24 to 27 inches, and is made of ash or hickory.

Various Tools used Underground.

WEDGES.—These are used in mines for breaking up coal or stone where blasting is undesirable. They may be applied by driving them into the joints or cleavages of the coal or stone, or in holes specially made for their reception by a pick or by some other boring apparatus. Wedges are made of steel, or iron with steel edges, and they vary in length from 6 to 12 inches, in width from 1 to $2\frac{1}{2}$ inches, and in thickness from $\frac{1}{4}$ to $1\frac{1}{2}$ inches. Wedges used in coal are much larger than those used in stone. These are the simpler form of wedges and also the best for bringing down coal, but they are not suitable for stone work, except for wedging off small pieces which may have been left by a shot. The more important kinds are those which substitute blasting, such as the *Wedge and Feather*, the *Patent Multiple*, and the *Hydraulic Wedge*.

HAND DRILLS.—Sometimes in coal mining the coal and stone are so strong and tenacious as to render the process of getting them down very slow and laborious; explosives are then applied to do the work more cheaply and expeditiously. Long narrow holes are bored by means of the hand drills, the charge in-



Rock Boring Machine. **Coal Boring Machine.**

serted and fired, the force of the explosion dislodging some of the rocks. A drill consists of a steel rod, of octagonal section, with a bit or chisel edge at one end and a striking face at the other; the bit is made either square or of a V shape, according to the hardness of the rock that has to be blown down. The ordinary shape is slightly curved at the bit end and is less liable to have the corners broken off in the hole. The width of the bit varies from 2 to 4 inches. Drills are made in lengths varying from 20 inches to 42 inches. A set of drills consists of a short drill about 20 inches long, a middle drill about 27 inches long, and a long drill about 42 inches. The operation of drilling is very simple. A man holds the drill in one or both hands and blows are dealt on the striking face with a hammer, which forces the cutting edge into the stone or coal. After each blow the drill is drawn outwards a few inches and turned slightly, so as to form a circular hole. When the short drill has bored its length, the longer drill is then substituted. A drill, called a *jumper*, is sometimes used in boring holes, and does not require the force of a hammer. It is generally made from 4 to 6 feet in length, with a chisel edge at one end, and at the other end the steel is bulged out so as to form a heavy ball and give the drill a greater weight. To use it, a short hole is first made with a pick, then the drill is inserted, and at each stroke it is *jumped* or pushed sharply into the hole; in this manner the hole is drilled. In some cases, however, machines are used instead of drills, with which a hole can be more speedily bored and with less labour.

HAND-BORING MACHINES. — Hand-boring machines with a rotary motion are much used in mining now-a-days instead of the sets of drilling gear just described. They are made very light for boring in coal and may be worked by one man. A machine consists of an iron frame, called a *standard*, which is fixed between the roof and thill, or between any other two bearing surfaces, at a convenient distance from the face. It is usually made in the telescopic fashion, so as to be adjustable to various heights and can be easily set and screwed up so as to remain firm whilst boring. A screwed rod passes through an iron box, which is threaded to suit the rod, and is also free to slide up and down the standard to suit the position of the borehole. A handle or ratchet is attached to one end of the screwed rod, and a twisted or auger-shaped drill at the other end to bore the hole. A backward and forward motion given to the ratchet by a man causes the auger to revolve, and the great amount of power gained by the screws causes it to bore a hole in the material in contact with it; it can also be made to bore at any angle For quick drilling of holes in shaft sinkings in iron-stone mines and stone drifts, machine rock drills worked by steam, compressed air, or electricity, are much used, and are made to do the work in the same way as the ordinary hand drills with hammers.

There is also a variety of other tools used underground for timbering, such as saws, hatchets, and dog and chains; and for road laying, such as wood chisels, clawed hammers, augers, adzes, gauges, wood levels, cold chisels, and other small tools.

JOSEPH WHEATCROFT.

ADVANCED.

TRANSMISSION OF POWER.

Question 2.—Describe the various methods employed in mining operations for transmitting power. Discuss the efficiency of the more important, and the special circumstances under which each are applied.

Answer.—Steam, water, air, ropes, and electricity are transmitters of power. In dealing with these I will first take steam, as it stands a long way in advance of all others as yet introduced for the transmission of power above and below ground. There is nothing so cheap and effective, and I am very much in favour of steam engines at the bottom of the shaft, either for pumping or haulage. There is a great loss of pressure

by steam passing through a long range of pipes, yet after due allowance is made for this deficiency, steam may be taken as the prime motive power. But for steam in-bye, I am not in favour of it for long distances, as the loss of power would be great.

Water.—Water is coming more to the front as a motive-power, and this we can say is a safe power and can be used with advantage when a sufficient head of water is obtainable. Surplus pumping power, as the hydraulic pumping arrangement (Jos. Moor's), or the water might be got from a hill side, such as a spring or from running water, this water to be conveyed in pipes to where it is required. The head of water could then be used to work a hydraulic pump to raise water out of a slope, or the power could be used to drive ventilating machinery and, if the quantity is sufficient, to work the haulage. In Moor's hydraulic pump advantage is taken of the incompressibility of water, and motion is given to a power ram by a steam engine, or from a column taken from the tubbing in the shaft, or from the main pumping set. The hydraulic pump is one of the best motive powers used for pumping water out of dip workings, being very effective when the pumps are situated close to the shaft. This class of pump requires little attention, and has been known to work when entirely submerged. The action of the motor consists of an ordinary cylinder with piston and piston rod, the diameter of the piston being regulated by the height of the motive column, the useful effect being only about 30 per cent., which is relatively small. The area of the motor piston is about one-third of the pump plungers. The water of the motive column is alternately admitted to each end of the cylinder and the exhaust water is discharged into the delivery pipe of the pump. The motive column has to be about ten times greater than the elevation to the shaft sump.

Compressed Air is now largely used for transmission of power both above and below ground, and in spite of the low useful effect, caused by loss of heat and increased friction, it is greatly favoured. The reason is in its comparative safety and the many ways in which it can be made to do useful work, such as pumping, haulage, ventilating, spraying the roadways, boring, and pressing water out of sump holes, etc. The points to be kept in view in laying down high-efficiency air-compressing plant are as follows, viz.:—The prime mover, almost necessarily a steam engine, should use steam as expansively as possible, and for this purpose the modern side-by-side two-cylinder compound engine is required. An air-compressing cylinder is placed behind each steam cylinder and worked with a through-going piston rod. A crank at right angles and a fly-wheel to give steady motion are indispensable; also a condensing apparatus if a good supply of cold injection water. Both engines are made to work independently of each other, so that either of them can be off for repairs without stopping the whole plant. Everything to be of the best material and workmanship. The air-compressing cylinder and its adjuncts are critical parts and require careful selection. The cylinder should have a water-tight jacket, in which a constant circulation should be maintained, and there should be a minimum of "clearance" between the piston and cylinder heads, at each end of the stroke. Automatic valves for admitting and releasing the air should have a grated seat so as to prevent any part of them, which may work loose, getting into the air cylinder. The air to be delivered into capacious reservoirs, which should have man-holes, pressure gauges, and safety valves fitted to them; any water which may accumulate in them being drained away by automatic traps. Compressed air is certainly of great advantage over steam in some places, but it is very costly on account of the power lost with no return. It requires expensive plant and gives from 25 to 30 per cent. effective power.

Ropes.—Transmission of power by ropes is a very good system. It may seem a drawback to have ropes hanging in a deep shaft, but the ropes are made light and yet very strong, and it must be remembered that the ropes in the shaft balance each other; they also convey power to other smaller ropes for hauling coal along different roadways, pumping water, etc.

Electricity has now been successfully applied to colliery work, and the energy can be easily transmitted from one place to another without pipes. It is by no means the last as a power. The danger of sparking has been overcome by closing in the brushes and their points of contact with the commutator, yet there is danger by anyone touching an exposed part of the circuit. (A man was killed and another received a very severe shock by taking hold of him to draw him off the cable at Lanemark Colliery, New Cummock, Ayrshire, Nov., 1894.) Even when the tension is not such as would cause a current to pass dangerous to life, unpleasant results might ensue. Large cables and low

voltage are essential in applying electricity to do mine work. As to the question whether compressed air or electricity is most economical, electricity is more powerful, steadier, and simpler to handle. The loss in transmission of power is less with electricity than with air. The liability to leak in pipes and friction is greater with air, sometimes being from 50 to 60 per cent., while with electricity it is only 30 per cent., which can be almost overcome by increasing the size of the conductor so that the resistance will be lessened in the transmission and by proper insulation. In the arrangement for electrical haulage a "motor" by gearing drives a drum. At the Abercanaid Colliery, South Wales, a plant replaces 27 horses. The motor is built to run at 800 revolutions, and makes 80 ampères at 850 volts. The dynamo will give 180 ampères at 500 volts, running at 550 revolutions. The cable is 3,200 yards long, and is composed of 37 strands of No. 14 high conductivity copper. Its resistance is 3,192 ohms, and there is a loss of potential of 51 volts, or 10 per cent. Electric locomotives have been built and a few are in use. They are fitted with accumulators, which store sufficient energy for one or two trips, thus doing away with overhead, underground, or side cables. An electric current may be generated either by steam or water, and made to do mechanical work, such as pumping, hauling, lighting, etc., by belt or spur gear. Priestman's Oil Engine is well adapted for all purposes about a colliery. THOS. E. AITCHISON.

FIRST-CLASS.

HAULAGE.

Question 3.—Give a detailed description of a method of haulage with which you are acquainted, giving dimensions of engine, etc., length of roads, quantity of coal hauled, etc.

Answer.—The following is a description of the method of haulage which I am acquainted with. It is the main and tail rope system as employed at Ouston A Pit, near Birtley, and is used to haul coal from five different landings, namely:—The 2nd North, which is 1,646 yards from the out-bye landing; the 1st North, which is 1,046 yards from the out-bye landing; the 4th West, which is 846 yards from the out-bye landing and which extends 100 yards from the main way; the Jubilee, which is 526 yards from the out-bye landing; and the New South, which branches off 100 yards from the landing but extends 550 yards in-bye. The engine is a double one, consisting of two cylinders 20 inches in diameter and 3 feet 4 inches stroke, and works with a steam pressure of 40 or 50lbs. per square inch. The drums are 4 feet in diameter, and are on the same shaft as the cranks, and are arranged so that they may be put in or out of gear by means of a clutch; there is also a brake to each drum. The engine is situated underground. The ropes are changed at the branch end from which the set is coming out, and when the landing-lad at any particular branch wishes to have his set out he signals to the main cabin by means of an electric bell; if all the other branches are rapped clear to the main cabin, the lad at the main cabin gives a specified number of rings to let him know that he has to change the ropes. When this is done and the switches put right, the landing-lad signals to the main cabin that he is ready. The lad in the main cabin then signals to the engineman to take the set out. When the set gets out-bye it knocks itself off automatically. The tail rope is then taken from the full set and placed on the fore end of the empty set, and the main rope is put on the hind part of the set. During the time that this changing has been going on, the engineman can have his tail rope drum put into gear, and when he receives a signal he takes the empty set in-bye to the same branch as the full set came out of. The landing-lad changes the ropes again, puts the switches right, raps clear to the main cabin, and any of the branches can then have a set out if they are ready. The ropes are changed as follows:—If the branch (see fig. 1, page 89, No. 8, Volume II) wishes to have a set out, and the other branches are clear, the lad uncouples the clips at the way end belonging to the main rope and couples them to the main rope of the branch; he also uncouples the tail rope clips and couples them to the tail rope in the branch. There are about 300 tons hauled per day out of this engine plane, which is in the Low Main seam, and the sets are made up of about 30 or 40 tubs each. The tubs are run down an incline into the Hutton seam to the shaft bottom. This incline is about 200 yards long, and has a fall of about 5 inches to the yard from the top end of the incline to a distance of about 100 yards, and the rest has a very slight inclination; it is worked by an endless self-acting chain. The tail rope on the engine plane is carried on sheaves, which are supported on uprights of wood, fixed by the side of the way; and the main rope is carried on rollers fixed in the middle of the way. The tubs, which are made of wood, carry 7cwt. each. MATTHEW J. ADAMSON.

AWARDS

For Answers to Competition Questions.—No. 4 Set.

Elementary.—Jos. Wheatcroft, 8, Longsight Terrace, Kinsley Hemsworth, near Wakefield.

Commended.—C. Barron, F. Cherry, W. T. Hewitt, M. Collinson, J. Prior, B. Turner, T. Lawrenson, T. Webster.

Advanced.—Thos. E. Aitchison, Green Hill, Dunaskin, Ayrshire.

Commended.—S. Davies, W. D. Harbit, W. P. Laws.

First-Class.—Matthew J. Adamson, Ouston Winning, Chester-le-Street.

Commended.—J. Jackson, G. Daykin, A. F. Martyn, J. Harrison, J. McPhail, J. H. Sherman, W. Slocombe, M. Brown J. Davies, S. Thorpe.

CORRESPONDENCE.

We will publish a reasonable amount of correspondence per issue, but subject to the following conditions:—

To be written on one side of the paper only.

Envelopes to be marked "Correspondence."

Name and address of sender must accompany such correspondence as a sign of good faith but the writer may assume a *Nom-de-plume* to be published if he so desires.

Correspondence must not be enclosed with Competition Answers.

The Editor will not hold himself responsible for any correspondence, nor will the publishing of it affirm that we hold the same views as the writer.

A Correction.

Sir,—I noticed in No. 26, Vol. II, whilst reading Mr. Samuel Davies's account of the Somersetshire coalfield, that he says, "The measures of this field are divided into three series:—(1) The upper consists of the Radstock group, containing four seams of coal, the aggregate thickness being about 12 feet." Now, Mr. Joseph S. Martin, in his (1893) report of the inspection of mines says, "At Camerton Colliery, five of the eight seams, constituting the upper division of the Upper or Radstock series of the Somersetshire coalfield, are worked." I think Mr. Davies is wrong, as I have seen more than four seams in the Radstock group.

Albert Street.

Answer to "Perseverance" Questions 1 & 3, in Vol. II., No. 26.

Sir,—1. There is a feeder of 300 gallons of water per minute at the bottom of a pit 250 yards deep. What arrangement of pumps would you adopt and why? Give size of pump and other particulars.

1st.—Find useful work to be done.

$300 \times 10 = 3{,}000$ lbs. of water per minute.

$3{,}000 \times 750 = 2{,}250{,}000$ units of work.

$2{,}250{,}000 \div 33{,}000 =$ H.P. Required $68\frac{1}{4}$ nearly.

2nd.—Find diameter of pump. We will assume that the pump is double-acting piston to travel at the rate of 200 feet per minute.

$300 \div 200 = 1{\cdot}5$ gallons for each foot the pump works.

$277{\cdot}274 \times 1{\cdot}5 = 415{\cdot}911$ cubic inches.

$415{\cdot}911 \div 12 = 34{\cdot}659$ square inches.

Allow 3·5 inches diameter for pump rod.

$= 9{\cdot}621$ square inches.

$34{\cdot}659 + 9{\cdot}621 = 44{\cdot}29$. Allow $\frac{1}{4}$ for waste and leakages.

$\frac{1}{4} + \sqrt{\frac{44{\cdot}29}{{\cdot}7854}} = 9$ inches diameter of pump.

3rd.—Find diameter of cylinder. Pressure per square inch on a 250 yard column $= 250 \times 3 \times 4333 = 324{\cdot}975$ lbs. pressure.

Total pressure on pump $= 34{\cdot}659 \times 324{\cdot}975 = 11261{\cdot}208525$ lbs.

$11261{\cdot}208525 \div 40$ lbs. steam pressure $= 281{\cdot}53$ square inches.

Add $\frac{1}{2}$ for frictional allowances.

$\frac{1}{2} + 281{\cdot}53 = 422{\cdot}29$ square inches area.

$\sqrt{\frac{422{\cdot}29}{{\cdot}7854}} = 23{\cdot}18$, say $23\frac{1}{4}$ inches dia. of cylinder.

Length of stroke is usually twice the diameter of cylinder, therefore we may call the length of stroke 4 feet, and it would work out as follows:—$\frac{200}{4 \times 2} = 25$ revolutions per minute.

I. Horse-power of engine required, $68\frac{1}{4}$.

II. Diameter of pump = 9 inch, length of stroke 4 feet, 25 revolutions per minute.

III. Diameter of steam cylinder $23\frac{1}{4}$ inches.

3.—What size of chain or steel rope would you require whilst sinking to carry a 14 inch set of pipes 80 yards in depth?

In order to find strength of rope or chain you must first of all find weight of pipes.

Rule for finding thickness of pipes—

T = Thickness of metal in inches.
D = Diameter of pipe in inches.
H = Head of water in feet that will burst pipe.

$\therefore T = \frac{D\,H}{72{,}000} = {\cdot}0466$ of inch.

Fraction of safety for forcing sets from 10 to 15, say 15 and we shall be on the safe side.

Thickness of pipe required $= {\cdot}0466 \times 15 = {\cdot}699$ inches.

A cast-iron pipe 14 inches diameter and ·699 inches in thickness, weight about 106 lbs. per foot.

$\therefore 106 \times 240 = 25440$ lbs.

Pipes with flanges weigh about 15 % more.

$\therefore 25440 + \frac{25440 \times 15}{100} = 29256$ lbs.

To this must be added weight of rope required, and for this a rope of the best plough steel, $5\frac{3}{4}$ inches in circumference, would be equal to the work, and this would weigh about 31 lbs. per fathom.

$\therefore 31 \times 40 = 1240$ lbs. weight of rope.

$\therefore \frac{29256 + 1240}{2240} = 13{\cdot}6$ tons total weight.

Take 8 as a safe factor, then breaking strain of rope would be $13{\cdot}6 \times 8 = 108{\cdot}8$ tons, so that we have a good margin, and it is better to be on the right side for safety. There are many rules given to find breaking strain of ropes, the following rule will be near enough for all practical purposes for ropes of this class:—

$5{\cdot}75^2 \times 3{\cdot}47 = 114{\cdot}5$ tons breaking strain.

$\frac{114{\cdot}5}{8} = 14{\cdot}3$ tons safe load.

Rule to find weight of cast-iron pipes—

= Cubic inches × ·257 = lbs. in weight. Add 15 % to this for flanges. This gives pretty near the result.

M.B.

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ONE PENNY.

CONTENTS.

EASY LESSONS ON MINE SURVEYING

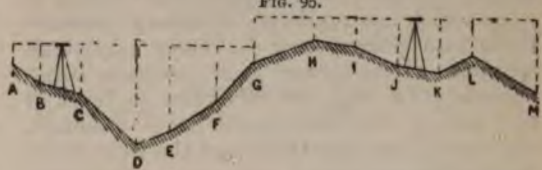
For Beginners.

Commenced in No. 2, Volume II.

LEVELLING.—Continued.

IF the distance is too great or there are too many irregularities in the surface of the ground to render it possible to do the work by one setting of the instrument, a series of operations connected to each other must be made. For example if it be required to ascertain the difference in level between the points A and M (fig. 96), the instrument must be set up a number of times, and the levels taken so that they will form a continuous series. Assuming the starting point to be A the staff is held at this point, and the surveyor proceeds towards M (not necessarily in a straight line) and sets up the instrument in some such position as shown and at such a distance from A as he deems convenient for taking a sight to that point. A sight is now taken to A and the reading is booked in the backsight column. The assistant then takes the staff on towards M, say to G, as far it can be seen with the level, a sight is taken to the staff held at this point, and the reading is booked as a foresight. The instrument is now taken up and set again as shown, care being taken however that the staff is not disturbed from the point G, until a backsight is taken from the instrument as set up in its new position, as the accuracy of the work depends upon the staff being retained at the same height while the position of the instrument is being changed. The backsight having been taken the staff-bearer proceeds on again in the direction of M, and holds the staff at that point, when a foresight is taken and the instrument is again removed. The series of operations thus proceed for any number of times according to the distance and nature of the ground. This is what is termed a "flying survey" and only enables us to calculate the difference in level between any definite points

FIG. 95.



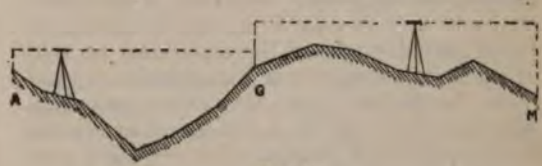


FIG. 96.

N.B.—The above are not drawn to a natural scale, the horizontal being different from the vertical.

without any relation to the ground between them. When a series of levels have been taken to form a section, the accuracy of the work is usually checked by flying levels taken from the two extreme points. For example fig. 95 represents the operations

necessary for making a section of the ground lying between A and M, while fig. 96 represents how a check would be taken by flying levels back again from M to A. It is unnecessary that the back and foresights, other than the extreme ones A and M of the repetition survey, should be the same as were taken in the section levels as we have shown it in the figures; in fact flying levels might be taken over extirely new ground, the only requirement being that the difference between the levels of the two extreme points be found, and if this approximately agreed with the difference as calculated in the section levels the survey could be accepted as correct. If the position of the backsights and foresights were the same in the flying levels as in the section levels, it would facilitate matters in case an error had been made, as it could be ascertained at what setting of the instrument the error was made, and it would not be necessary for the whole of the levelling to be done again. Another method of checking extensive levels is by means of the *bench marks* left by the Government Ordnance Surveyors. These bench marks are in the form of the broad arrow, and are left on stone houses, walls, mile posts, or any other permanent edifice in a convenient and accessible position. The height of these marks above sea level may be found by referring to the Ordnance Maps, and in order to check a series of levels it is only necessary to commence at one of these marks and tie in to another. As has been previously stated, if the difference between the levels of the points A and B is all that is required, the observations which are rendered necessary between these two points may be taken anywhere without necessitating their position being known. To find the difference in level of two points from compound level readings, the sum of the foresights and the sum of the backsights are taken and one is deducted from the other. If, however, a section of the ground is required the staff must be held at the commencement of all undulations, and must be in the line of section required. Measurements of all distances must also be made so that the position of every sight may be fixed. The position of the instrument is not required, and it may be placed on any side of the section line which may be convenient for taking the sights. The following shows the method of booking a compound level survey when a section of the ground is required. The position of the sights are shown by fig. 95:—

LEVELS OF GROUND FROM A TO M (FIG. 95).

Distance in Feet	Sights.			Rise	Fall	Reduced Levels	Remarks.
	Back	Inter	Fore				
0	2·56	..	..	..	..	10·00	From A
34	..	4·90	..	..	2·34	7·66	B
85	..	6·00	..	..	1.10	6·56	C
153	..	12·26	..	..	6·26	·30	D
196	..	10·48	..	1·78	..	2·08	E
251	..	6·76	..	3·72	..	5·80	F
298	5·76	..	1·88	4·88	..	10·68	G
372	..	2·86	..	2·90	..	13·58	H
424	..	3·70	..	..	·84	12·74	I
479	..	5·86	..	..	2·26	10·48	J
528	..	6·62	..	..	·66	9·82	K
569	..	4·66	..	1·96	..	11·78	L
647	..	..	9·20	..	4·54	7·24	To M
	8·32		11·08 8·32	15·24	18·00 15·24		
		Diff.	2·76	Diff	2·76		

and 10·00 — 7·24 = 2 76 difference.

It will be seen from the bookings that the first sight to A is termed a backsight, and that the sight taken to G is termed the foresight, as this is the point which forms a basis for the next series of levels. All the sights taken between A and G to get off the irregularities of the ground, so as to make a section, are termed the intermediate sights. The sight back to G from the instrument when fixed in its second position is the backsight for the next series of levels, and is booked in the same line as the previous foresight taken, but of course in another column. The rise and fall columns are calculated as previously shown in the simple levels. If the reading at any point is less than the one preceding, there is a rise* at that point equal to the difference between the two readings, and if it is less *vice versa*. Thus there is a fall at B of 4·90 — 2·56 = 2·34, a further fall at C of 5·00 — 4·90 = 1·10, and a still further fall at D of 12·26 — 6·00 = 6·26. At E however we find that the reading is 10·48, and at the preceding point D it is 12·26, therefore there is a rise at D of 12·26 — 10·48 = 1·78. Similarly there is a rise at F of 3·72. Now at G we have two readings and no mistake must be made as to which must be considered in finding the fall or rise at this point. It is the *foresight*. The difference between the foresight and the preceding sight must be taken, and the result booked as a rise or fall as the case may be, of the point G. The reading of F is 6·76, and the foresight to G is 1·88, therefore there is a rise at this point of 6·76 — 1·88 = 4·88.

(*To be continued.*)

*This was stated incorrectly in last issue, being given as a *fall* instead of a *rise*.

COMPETITION QUESTIONS.

No. 8 SET.

TO the sender of the best set of Original Answers in each Stage will be awarded the following:—

Elementary 2s. 6d., Advanced 3s. 6d., First-Class 4s. 6d.

A Competitor may only answer one Stage in each issue, though a different Stage may be taken in another issue. The best answer to each question will be published with the sender's name and address.

1.—All envelopes must be marked "COMPETITION."

2.—To be written on separate sheets of paper with name attached, and on one side of the paper only. Sketches to be in ink on *unruled* paper.

3.—Correct name and postal address must be sent.

4.—They must reach us by February 8th, 1895.

5.—The Editor's decision as to winners to be final.

ELEMENTARY.

Question 1.—How is the ventilation of a mine effected by a furnace and how by a fan? Describe the arrangements of the upcast shaft in each case. Give sketches.

Question 2.—What precautions are necessary when approaching old workings?

ADVANCED.

Question 3.—What is Koepe's system of winding? Give sketches.

Question 4.—Describe with sketch the Muesler safety lamp.

FIRST-CLASS.

Question 5.—If it was decided to tap a large accumulation of water from old workings how would you proceed and what arrangements would you make so that the flow of water would not exceed the pumping capacity of the pit? Give sketches.

VENTILATION.

CRITICISM OF COMPETITION QUESTION.

By JOSEPH CARTER, First Class Certificated Manager.

IN reference to the above, which appeared in No. 3 of Vol. III., by Mr. Myles Brown, as he wishes other opinions as to which rule is the more exact, I would use the one he has worked, applying "Atkinson's Formulæ" as shown herewith:—

I.—In airways of different dimensions, the pressure increases or decreases as the cube of velocity and proportionate to the rubbing surface. As an example take the two airways in question, and apply the above rule and see the result.

A current of air is maintained in a road 6 feet square by a W. G. of 1 inch, what pressure will be required to pass the same quantity through one 5 feet square and of the same length.

Example:—If the velocity in the large airway was 1, then the velocity in smaller airway would be 1·44 to send the same quantity of air through.—

$$\frac{36}{25} = 1{\cdot}44$$

$$\text{Therefore } \frac{1^3}{24} : \frac{1{\cdot}44^3}{20} :: 1 \text{ or}$$

$$\frac{1{\cdot}44^3 \times 20 \times 1}{1^3 \times 24} = \frac{59{\cdot}71968}{24} = 2{\cdot}48832 \text{ W.G.}$$

$2{\cdot}48832 \times 5{\cdot}2 = 12{\cdot}939264$ lbs. pressure per square foot,

or direct from the pressure

$$\frac{1{\cdot}44^3 \times 20 \times 5{\cdot}2}{1^3 \times 24} = 12{\cdot}939264 \text{ lbs. as before.}$$

Students will do well to note the difference of variation in pressures of same airways and as above. In airways of same dimensions the pressure increases as square of velocity, but in different areas as cube of velocities, and proportionate to rubbing surface.

Mr. M. Brown gives a rule from "Wardle's Practical Coal Mining," which says that "Pressures vary inversely as their areas cubed."

$$\frac{36 \times 36 \times 36}{25 \times 25 \times 25} = \frac{46656}{15625} = \frac{1 \times 46656}{15625} = 2{\cdot}98 \text{ W.G.}$$

$2{\cdot}98 \times 5{\cdot}2 = 15{\cdot}496$ lbs. pressure per sq. ft.

Now this rule is all right when the different areas have the same amount of rubbing surface. When the areas and rubbing surfaces are different we must take both into consideration, this shews that the above W. G. 2·98 is too much, and consequently the result must be wrong. In order to point out more clearly that the pressure obtained by the above rule is too great, apply the following rule to obtain velocities in same airways:—

Rule II.—Velocities in the same airway increase or decrease as the square root of pressure. So that if 12·939624 lbs. pressure produced a velocity of 1·44 in an airway,

what velocity would be produced in the same airway with a pressure of 15·496 lbs.?

$\sqrt{12{\cdot}939624} : 1{\cdot}44 :: \sqrt{15{\cdot}496} = 1{\cdot}58$ velocity

If we take the velocity of the larger airway to be 1, then the velocity of the smaller one will be 1·44 to send the same quantity of air through, and not 1·58 which is too great. This difference of velocity seems small, but when dealing with large quantities the excess would be very great. To shew that the rule I have given is correct I will take a corresponding rule and obtain the velocities from the pressure given and the one obtained. In airways of different dimensions, velocity increases or decreases as the square root of the pressure, and proportionate to the square root of rubbing surface or perimeter. The airways in question are 6 feet × 6 feet and 5 feet × 5 feet, W. G. 1 inch or 5·2 lbs. per square foot. Velocity 1 in the larger road and 12·939264 lbs. pressure in smaller one. Find the velocity in smaller airway?

$$\frac{1 \times \sqrt{12{\cdot}939264 \times 20}}{\sqrt{5{\cdot}2 \times 24}} = 1{\cdot}44 \text{ velocity,}$$

which is the correct proportionate velocity according to the question given.

The rule as given in Mr. Wardle's book, if, as stated, means that airways such as the following, 10 feet × 10 feet and 15 feet × 5 feet—

Large airway, perimeter = 40
Small „ „ = 40

come under it because the rubbing surface or perimeter is the same in each case, but when the perimeters are different as here (6 feet × 6 feet and 5 feet × 5 feet)—

Large airway perimeter = 24
Small „ „ = 20

Thus the rubbing surface must always be taken into account as I have described.

Students would do well to work the following examples, and prove for themselves the rules given:—

Rule III.—Velocities increase or decrease as square root of pressure, and proportionate to the square root of rubbing surface or perimeters—

$$\text{Velocity} = \frac{60 \times \sqrt{24{\cdot}9989 \times 20}}{\sqrt{{\cdot}7812 \times 40}} = 240 \text{ velocity.}$$

$$\text{V. from W.G.} = \frac{60 \times \sqrt{48 \times 20}}{\sqrt{{\cdot}15 \times 40}} = 240 \text{ velocity.}$$

$$\text{V. from H.P.} = \frac{60 \times \sqrt{4{\cdot}545 \times 20}}{\sqrt{{\cdot}142 \times 40}} = 240 \text{ velocity.}$$

We will now find the pressure, W. G. and H. P., also the velocity in large air-way from the result obtained in smaller airway.

$$\text{Pressure} = \frac{24{\cdot}9984 \times 60^3 \times 40}{240^3 \times 20} = {\cdot}7812 \text{ lbs.}$$

$$\text{W. G.} = \frac{4{\cdot}5 \times 60^3 \times 40}{240^3 \times 20} = {\cdot}15 \text{ W. G.}$$

$$\text{H. P.} = \frac{4{\cdot}545 \times 60^3 \times 40}{240^3 \times 20} = {\cdot}142 \text{ H. P.}$$

$$\text{V. from Pressure} = \frac{240 \times \sqrt{{\cdot}7812 \times 40}}{\sqrt{24{\cdot}9984 \times 20}} = 60 \text{ velocity.}$$

$$\text{V. from W. G.} = \frac{240 \times \sqrt{{\cdot}15 \times 40}}{\sqrt{48 \times 20}} = 60 \text{ velocity.}$$

$$\text{V. from H. P.} = \frac{240 \times \sqrt{{\cdot}142 \times 40}}{\sqrt{4{\cdot}545 \times 20}} = 60 \text{ velocity.}$$

Work out these examples for yourselves and compare the answers obtained with those given in Atkinson's, and you will find that they work out correctly.

In order to show this more clearly take the following as examples, and work them according to the rules I have given and see the result. The examples above and below are taken from Atkinson, because the students can compare the answers here arrived at (by the rules here given) with those in Atkinson's book and those students who have not got this work would do well to get it, because the fundamental laws of ventilation are therein explained:—

Example—An airway 10 feet × 10 feet and 25,000 feet long, passing 6,000 cubic feet of air per minute, with a pressure of ·7812 lbs. per square foot, W.G. ·15, H.P. ·142. Find pressure, W.G. and H.P. to send the same quantity of air through an airway 5 feet by 5 feet, and 25,000 feet long.

Now to send 6,000 cu. ft. through an airway 10 by 10, V. = 60
„ „ „ „ „ 5 by 5, V. = 240

As both airways are equal in length we can simply take the perimeter of a section.

Perimeter of large airway = 40 feet.
„ small „ = 20 feet.

Rule I.—Pressure varies as cube of velocity and proportionate to rubbing surfaces.

$$\text{P.} = \frac{{\cdot}7812 \times 240^3 \times 20}{60^3 \times 40} = 24{\cdot}9984 \text{ lbs.} \quad \text{See Atkinson}$$

$$\text{W.G.} = \frac{{\cdot}15 \times 240^3 \times 20}{60^3 \times 40} = 4{\cdot}8 \text{ W.G} \quad \text{do.}$$

$$\text{H.P.} = \frac{{\cdot}142 \times 240^3 \times 20}{60^3 \times 40} = 4{\cdot}545 \text{ H.P.} \quad \text{do.}$$

To demonstrate more clearly that the rule in Wardle's book, and referred to by Mr. Brown, relates only to airways of different areas having the same rubbing surfaces, and not to airways having both areas and rubbing surfaces different, I give the following:—

Take the airway 5 feet × 5 feet with a velocity of 240, and 24·9984 lbs. pressure per square foot.

1st.—Find pressure by Wardle's rule, areas cubed—

$$P. = \frac{60^3 \times 24{\cdot}9984}{240^3} = {\cdot}3906 \text{ lbs. pressure per sq. ft.}$$

2nd.—Find velocity from the pressure obtained—

$$V. = \frac{240 \times \sqrt{{\cdot}3906 \times 40}}{\sqrt{24{\cdot}9984 \times 20}} = 41{\cdot}9 \text{ velocity, say 42.}$$

Compare these results with the answers given in Atkinson's, and see the difference.

Pressure ·3906 is too small, because rubbing surface is twice as great in the larger airway as in the small one, and this has not been taken into account, therefore the velocity is also too little:—

The pressure should be ·7812. See Atkinson.
The velocity „ 60 „

I hope that I have made this clear enough for the readers of this Journal, and I am sure that if those students who are wishful to grasp this subject, will only work out the examples given, for themselves, they will gain a far greater knowledge than by simply reading them over. I have given the two examples from Atkinson, because it is a standard work, and the answers given have been proved over and over again to be correct.

COAL-DUST EXPLOSIONS.

RECENT colliery explosions have shown the dangerous behaviour of coal-dust in being able to carry on the explosive wave in the workings of a mine. Further, the valuable experiments of Mr. Galloway, and of Mr. Hall, H.M. Inspector of Mines, have proved the fact that a mixture of coal-dust and air without the presence of coal gas, can be ignited by means of a blown out shot of gunpowder and initiate an explosive wave. If we suspend coal-dust in air, or even in oxygen gas, we find that it is almost an impossibility to ignite such a mixture by means of a naked flame, and owing to this difficulty there are many people who still believe explosions of coal-dust and air to be an impossibility. Professor Dixon has shown that when bodies containing carbon burn in air, it is probable that the carbon combines with the oxygen forming not carbonic acid gas (CO_2) direct, but the intermediate product carbonic oxide (CO), and that this gas then combines with oxygen to form carbonic acid gas. Professor Vivian Lewis has further shown that whilst mixtures of coal gas and air are very difficult to ignite, the mixture becomes very inflammable if carbonic oxide gas be present. This may account for the ease with which a blown out gunpowder shot will set fire to coal-dust. If we examine the resultant fumes generated on firing various explosives, we find that nearly all of them give off more or less of this poisonous and dangerous gas carbonic oxide (CO). The following table shows the composition of gases produced by the principle mining explosives in use in this district:—

		Combustible Gases	
	Carbonic Acid Gas	Carbonic Oxide	Hydrogen & Marsh Gas
POWDER.			
Gunpowder	50·6	10·5	3.1
Blasting Powder	33·1	33·7	7·1
SPRENGEL EXPLOSIVES.			
Roburite, Ammonite, Bellite, &c.	32	Nil.	Nil.
NITRO-GLYCERINE EXPLOSIVES.			
Nitro-Glycerine	63	Nil.	Nil.
Gelignite	35	7	Nil.
Carbonite	19	15	26
Blasting Gelatine	36·5	32·5	3·6
NITRO-COTTON EXPLOSIVES.			
Tonite	30	6	Nil.

It will be seen from the above that all the explosives except those of the Sprengel type give off carbonic oxide gas. This is due to the presence of an excess of carbonaceous material, added generally to cheapen the article. Imagine the heated gases from a blown out shot containing carbonic oxide coming in contact with suspended coal-dust, it is easy to see how, if the temperature be high enough, the dust will readily catch fire and burn. A number of experiments were here performed by Mr. Orsman, who, resuming, said with one of the above explosives, namely, carbonite, it is very easy to show even on a small scale how dangerous the fumes may become. Carbonite consists of:—

Nitro-Glycerine,	25	parts
Wood Meal	40	„
Potass Nitrate	34	„

It will be noticed that no less than 40 per cent. by weight of this explosive is sawdust. This admixture damps down the temperature of detonation and the energy of the nitro-glycerine, the relative strengths of this explosive compared with explosives of the Sprengel type being 100·140. The excess of wood meal in carbonite means the formation of 41 per cent. of combustible gases. On detonating 10 grams of this explosive packed in a leaden cartridge case, suspended in a strong steel cylinder, we obtain over 2,000 c.c. of mixed gases. On allowing the gas to escape by means of a small tap, we find that on applying a light it will catch fire and continue burning. If now we mix the gases from carbonite with air and shake in coal-dust, on applying a light, a fiery explosion occurs, the coal-dust catching fire and burning readily. It may be argued that it is very difficult to ignite coal-dust with a blown out carbonite shot. This is due to the low temperature of combustion, but if part of the cartridge happened to be blown out of the hole undetonated in a burning condition, then an explosion of coal-dust might be initiated. Further, the production of carbonic oxide (CO) in the mine is very deleterious to health, one-half per cent. in the air being fatal to life. With the Sprengel explosives, the excess of oxygen from the nitrate of ammonia prevents the formation of any of this gas and its consequent dangers.

At a meeting of the Manchester Geological Society on the 11th inst., when a paper was read by Mr. D. H. F. Mathews, H.M.I.M., on the Damping of Coal Dust in Mines, the above note on Coal Dust Explosions was also contributed by Mr. W. J. Orsman, F.I.C., F.C.S.

Flameless Explosives.

The following are the conclusions arrived at by the Explosives Committee of the North of England Institute of Mining and Mechanical Engineers, and published by them after their recent experiments with so-called flameless explosives:—

1.—All the high explosives (ammonite, ardeer powder, bellite, carbonite, roburite, and securite) are less liable than blasting-powder to ignite inflammable mixtures of air and fire-damp. These explosives, however, cannot be relied upon as ensuring absolute safety when used at places where inflammable mixtures of air and fire-damp may be present.

2.—The variable results following upon the detonation of high explosives appear to be due in some measure to defective admixture of or variation in the proportions of the ingredients used in the manufacture of the explosive.

In view of the changes from time to time made in the proportions and constituents of high explosives, it seems desirable that this information should be afforded by the manufacturers to the users of the explosive.

3.—In the storage of high explosives, it is desirable that every care should be taken to ensure their being maintained in a proper condition. It is also certain that these explosives alter in character with age.

4.—It is essential that similar examinations of the working-places and precautions which are in force in mines where blasting-powder is used, should be rigidly observed when a high explosive is employed.

5.—In selecting a high explosive for use in a mine, it should not be forgotten that the risk of explosion is only lessened and not abolished by its use.

6.—All of the high explosives on detonation produce evident flame.

7.—The emission of flame from a blown out shot of a detonated high explosive is not prevented by the quantity or length of stemming used.

8.—In the case of a charge of a high explosive which has missed fire, if a short length of stemming (proved up to 8 inches) has been employed, the charge can be detonated by another cartridge of the explosive and additional stemming being placed in the hole in front of the original stemming.

AWARDS

For Answers to Competition Questions.—No. 5 Set.

Elementary.—Jos. Wheatcroft, 8, Longsight Terrace, Kinsley Hemsworth, near Wakefield.
***Commended.*—T. Webster, R. Cherry, M. Collinson, N. W. Hardy, J. Kinch, D. Turner.**

Advanced.—H. Hall, Woodland, County Durham.
***Commended.*—H. Hall (Ryhill), J. Wells, S. Davies, J. Stephenson, T. Rimmer, J. Hardman, T. E. Aitchison, J. Crone, R. Cockburn, H. Talbot, J. Jones, W. Vickers, W. Sutherland, J. Walsh.**

First-Class.—M. Brown, Butterknowle, Darlington.
***Commended.*—J. Davies, S. Thorpe, J. McPhail, W. Slocombe, J. Jackson, G. Daykin, M. J. Adamson, J. Harrison, T. Wallett.**

Colliery Managers' Exams.—Seven of the successful candidates in the First-class Exam., and seven of those in the Second-class Exam., held at Nottingham, in October last; and two successful in the First-class and ten in the Second-class at Bristol, in September last, are Students of the Universal Mining School, Derby, conducted by Mr. T. A. Southern, late H.M. Inspector of Mines.

ANSWERS TO QUESTIONS

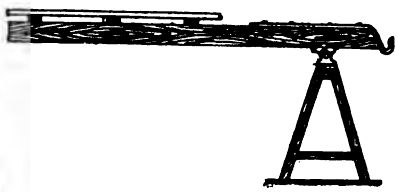
No. 5 Set—In No. 2, Vol. III.

ELEMENTARY.

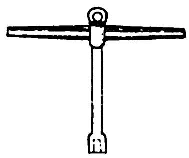
BORING WITH RIGID RODS.

Question 1.—Give a detailed account, with sketches, of the ordinary method of boring with rigid rods ?

Rocking Lever.



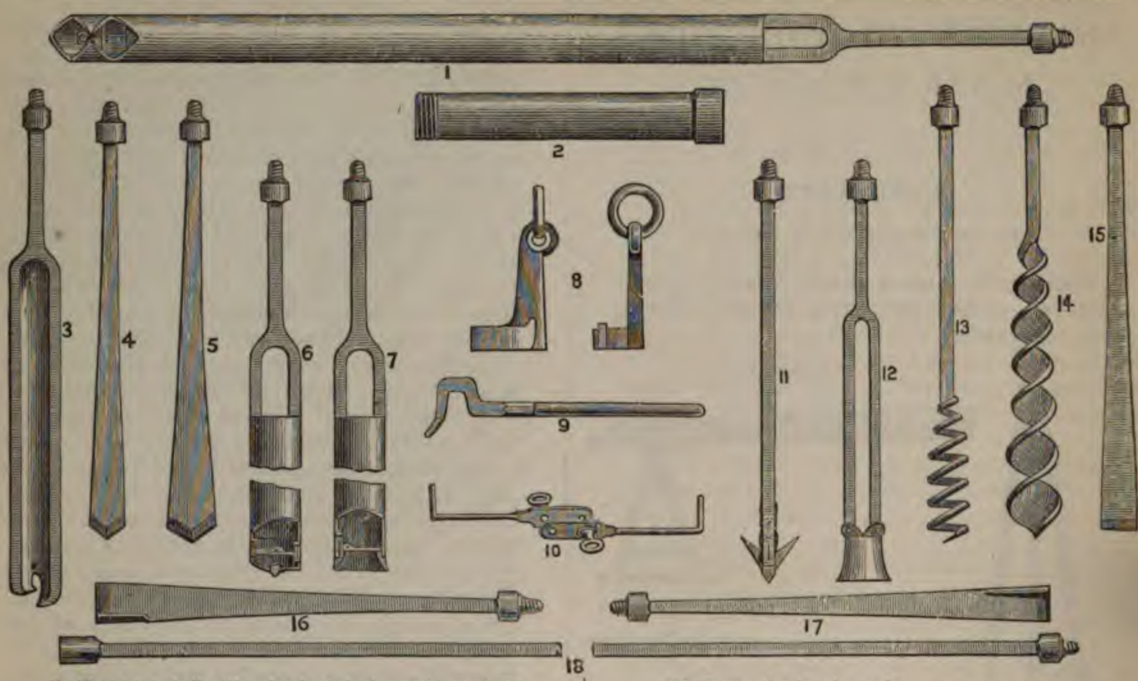
Headgear with Windlass.



Bracehead.

Answer.—The existence of a coal seam having been ascertained, or at least shown to be highly probable, trial-boring may now be commenced. By boring is meant the making of a perpendicular hole of small diameter, in the crust of the earth, to ascertain the nature and thickness of the rocks, more especially the coal measures. The ordinary method of boring is accomplished by the use of iron rods, called bore rods, attached to the bottom of which is the cutter or chisel for the actual boring of the hole. At the top there is a double pair of handles, generally of wood, called a brace-head, by means of which the rods are raised and worked in the bore-hole. To cause the chisel to cut into the rocks two men take hold of the brace-head and raise the rods a few inches, then allowing them to drop sharply to the bottom of the hole, to force the chisel into the stone. In order to make the hole as circular as possible, each time the rods are raised the men at the brace-head give them a partial turn in such a direction as will prevent any of the rods from becoming unscrewed. This movement causes the chisel to drop on fresh ground each time, thus preventing it from wedging itself and at the same time making a circular hole. In course of time the stone at the bottom of the bore-hole becomes broken up into small pieces by the action of the chisel and the hole has then to be cleaned out. The rods are withdrawn, the chisel taken off and replaced by a cleaning instrument, termed a sludger or wimble. This is lowered into the hole and, being hollow, the debris works into it by raising and lowering it alternately; it is then raised to the surface and emptied, and lowered again if required. The chisel is screwed on again, the rods lowered and the boring recommenced. Additional bore-rods are screwed on at the top as the bore-hole increases in depth. The thickness of each bed passed through may be found by marking the rods when a fresh stratum is entered and the nature of the rocks may be ascertained by carefully examining the contents of the sludger when emptied at the surfaee. Thc information thus gained is written down in a note book used specially for that purpose, thus a complete section of the strata passed through is obtained when the bore-hole is finished. When the bore-hole has reached a depth of about 10 or 15 fathoms and the weight of the rods has become too great for the men at the brace-head to lift, other appliances, such as the rocking-lever, are required to assist them. When it is expected that the boring has to be continued to a great depth the rods must be very strong and complete, and a windlass and headgear are also necessary to raise the rods. In deep bore-holes accidents are liable to occur from fractures of the rods, stripping of the screw-threads, pieces breaking off the chisel when boring is going on, part of the rods falling into the bore-hole during the process of taking them out or putting them in, or anything falling into the bore-hole. Such accidents as these prevent the boring from being continued until the bore-hole is cleared from the broken pieces or rubbish. The tools used for this purpose are shown by the figures. The crow's foot is used to extract broken rods when the fracture is just above a joint, but when a fracture occurs a few feet above a joint the bell-box is used. Sometimes, however, instead of the bell-box, the wad-hook or spiral worm is employed for the same purpose.

JOSEPH WHEATCROFT.

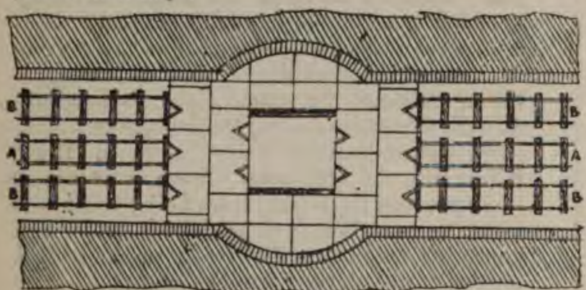


1 Shoe-nose shell with valve for bringing up loose stuff
2 Wrought-iron screwed well bore pipes
3 Auger for clay and stiff soil
4} 5} V nose chisels for hard ground
6 Shell auger with valve for loose and wet soil
7 Bell shell with valve for loose gravel
8 Lifting-dog for raising rods
9 Pair of rod wrenches for screwing and unscrewing rods
10 Levers for turning rods
11 Spring dart for drawing pipes in bore-holes
12 Bell box for bringing up broken bits
13 Spiral worm for extricating broken rods
14 Worm auger for loosening stuff in bore-holes
15 Square nose chisel
16 S nose chisel for hard strata
17 T nose chisel for hard strata
18 Rods with screw joints in 5 and 10 feet lengths

ADVANCED.

PIT BOTTOM ARRANGEMENTS.

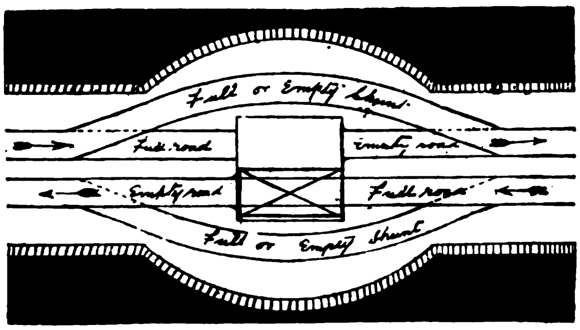
Question 2.—Describe with sketch how you would lay out a pit bottom for an output of 600 tons a day?



Answer.—When driving from the shaft through the solid coal to form the shaft pillars, it should be borne in mind that the first 150 yards on each side of the shaft will form the sidings. That is, where the coals arrive from all parts of the mine to be sent to the surface, and where all the empty tubs are despatched into the mine, also where the men and boys travel when entering and leaving the mine. Therefore it is very desirable that these levels should be made perfectly straight with plenty of width and height so that the work may be carried on with despatch, economy, and safety. The shaft bottom and roadways for some distance are generally arched to secure the roof and sides. Sometimes the arching is only carried a few yards along the roads from the shaft bottom, and the rest of the siding can be secured by building sidewalls and stretching iron or steel girders across from one side to the other. The figure shows the shaft bottom arrangements where there would be no difficulty in dealing with an output of 600 tons per day. It will be seen that round about the shaft bottom is laid with flat sheet iron, which allow the tubs being easily and quickly turned in any direction, and a road by the shaft sides enables the tubs to be sent from one side to the other in case the quantity obtained on each side are unequal. AA is the road on each side of the shaft for empty tubs, BB,BB are the roads for the full tubs;

and these roads are connected together with points and crossings. The roads should have a slight rise from the shaft so as to facilitate the moving of the full tubs and cause the water to run to the sump, which will keep the siding dry. Flat-bottom rails in 12ft. lengths and weighing from 24 to 30lbs. per yard are used, and are jointed together by fish plates. These fish plates have holes punched through them which correspond with the holes in the rails, and they are placed on each side at the joint, a bolt is then put through each hole of the fish plates and rails and screwed up tight. These rails are laid upon sleepers, which may be either of wood, iron, or steel, and made secure. When these rails are laid upon wood they are generally made fast by driving dogs down each side of the rails into the sleeper

H. HALL, Woodland, Co. Durham.



We consider this sketch shewing bell-mouthed shaft, by H. Hall, Ryhill, also worthy of publication.

TESTING FOR GAS IN COAL MINES.

Question 3.—How would you test for the gases met with in coal mines, and where would you expect to find them?

Answer.—The gases met with in coal mines are Light Carburetted Hydrogen (CH_4), Carbonic Acid (CO_2), Carbonic Oxide (CO), Sulphurretted Hydrogen (H_2S), and After-damp. Owing to the lightness of Carburetted Hydrogen (very little more than half as heavy as air) we may expect to find it in the highest parts of the mine, near the roof, in all cavities and places where falls of stone have occurred. It accumulates in the goaves which are difficult to ventilate and will be found at the goaf edge upon a decrease of atmospheric pressure. It is generally found given off from faults in large quantities.

The method of testing for fire-damp with a safety lamp, which is generally used, is as follows:—The light is lowered by drawing down the wick, then holding the lamp in one hand and screening the eyes with the other the lamp is cautiously raised towards the roof. If any gas is present a blue cap will appear on the light, which varies in size according to the quantity of gas present. It requires an experienced man to examine places containing CH_4 with a sensitive lamp, and before going into the mine the lamp should be examined, put in good order, and securely locked. The amount of gas that may be detected by this method is from two to three per cent., but since it has been shown by Sir F. Abel that if coal dust be present 1·5 per cent. of gas in air will render the mixture explosive, a more delicate test is required.

A lamp specially constructed to show smaller quantities of gas, when present, is the "Pieler" lamp. It is constructed on the principle that a certain elongation of the flame is equal to a certain proportion of fire-damp. In construction it is a long Davy enclosed in a tin case, with a blue glass front, and burns with spirits of wine. There is a scale fixed on the outside of the case to indicate the percentage of gas present. One quarter per cent. of fire-damp can be detected by this lamp.

CARBONIC ACID (CO_2) is known to miners as black-damp, choke-damp, or stythe. It is given off from the strata, from the explosions of blasting agents, combustion of lights, respiration of men and horses, and the decomposition of mine timber. More of this gas is found in shallow damp mines than the deep dry ones. CO_2 has a specific gravity of 1·528, which is much heavier than air, consequently it sinks to as low a point as possible. Owing to its weight it is generally found near the floor, in badly ventilated dip workings, and when water is standing. Its presence is usually manifested by its acid taste and its influence on the flame of a candle. As carbonic acid gas is a non-supporter of combustion it causes a light to burn with a dull and heavy flame, and when in larger quantities lights are extinguished. When 3 to 4 per cent. is present it is unfit to breathe and produces faintness. When 8 per cent. is present it is fatal to life, and when 10 per cent. is present lights will not burn.

CARBONIC OXIDE (CO) is called white-damp. This gas is the result of imperfect combustion, and is produced in mines when incomplete combustion occurs, such as gob fires, when gunpowder is exploded under certain conditions, sometimes by furnaces or fires em-

ployed in a mine, and it is stated to be abundantly produced where explosions of coal dust occur and after an explosion of fire-damp. Owing to its density (Sp. Gr. ·975) it will tend to occupy the highest places of a mine and is also found in the neighbourhood of gob fires. It will burn when mixed with air, producing a pale blue flame, but the flame is not elongated until 12½ per cent. CO is present. It is detected by its sweet but peculiar odour and its action on the system of the person breathing it. In small proportions it causes trembling in the limbs, loss of strength, severe headache, giddiness, and fainting.

SULPHURETTED HYDROGEN (H_2S).—This gas is only found in small quantities. It is given off by the decomposition of iron pyrites in the presence of water or in damp places, and occasionally it may be found when gunpowder has been exploded. It is generally met with in old workings and sometimes in the neighbourhood of gob fires. Its presence is immediately detected by its characteristic and offensive smell, which resembles that of rotten eggs. When 1 per cent. of this gas is present in the air it produces sickness, fainting fits, and loss of sensation, and a light will burn brightly in a mixture unsafe to breathe. H_2S does not support combustion, but is in itself combustible, that is, it will burn in the presence of air with a blue flame.

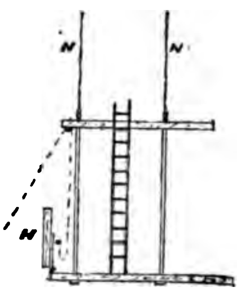
AFTER-DAMP.—This gas is always found in mines after an explosion of fire-damp, and is a mixture of that gas with air. It is a deadly mixture and affects the eyes and the system generally of those inhaling it, producing a drowsy feeling, which becomes more difficult to overcome as the duration is prolonged, causing insensibility and death very quickly. It also possesses a slightly pungent gaseous smell. H. HALL, Woodland, Co. Durham.

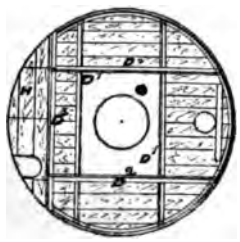
FIRST-CLASS.

GALLOWAY'S BRICKING SCAFFOLD.

Question 4.—Describe with suitable sketch Galloway's patent bricking scaffold, and state its advantages.

Answer.—Galloway's walling stage consists of two floors or stages, 10 feet 6 inches apart. The lower frame consists of four pieces of angle-iron D¹ D² crossing each other at right angles, to which is attached the circular platform of timber. The part H of the lower stage is hinged for the purpose of allowing that segment to be lifted on passing buntons. Four upright pieces of angle-iron connect the upper frame and the lower one, and four sheets of iron are attached to these four uprights, thus enclosing the circular hole which is in the centre of the floor. The roof or higher stage is formed similar to the floor or lower stage, but is rather less in diameter and is not made to cover the hinged segment below. An iron ladder provides a means of access from one stage to the other. The whole stage weighs about five tons and is suspended from the guide ropes NN, which are 5 feet 6 inches apart from centre to centre.





The advantages of Mr. Wm. Galloway's walling stage are:—(1) It ensures greater safety to the workmen than an ordinary single stage, as it protects them from any falling material by the use of the top stage; also the central hole is protected, so that there is no danger of workmen falling into the pit whilst working on the lower stage. (2) Owing to it being attached to the guide ropes it can be manipulated as required during the time of walling; and (3) The suspension ropes act as a guide for the hoppit.

MYLES BROWN.

ACCIDENTS IN MINES AND THEIR PREVENTION.

Question 5.—What are the principal causes of accidents in mines, and what would you do to minimise them?

Answer.—The principal causes of accidents in mines as ascertained by consulting the various inspectors' reports are shown by the annexed table:—

Year 1893	Death-rate from Accidents per 1,000 Persons				
UNITED KINGDOM	By Explosions of Fire-damp	From Falls in the Mine	In Shafts	Miscellaneous Accidents	From all Causes Underground
Percentages...	·291	·749	·187	·486	1·713

An occupation with an unusual mortality of 1·713 per 1,000, is no doubt a very hazardous one, and one which calls forth the dexterity and tact of all those concerned in the management of the various departments with which the persons under consideration are connected. The one important item to be considered being that of lessening the percentage of accidents. To minimise accidents may perhaps be easily stated on paper, with pen and ink, but to be confronted with the difficulties of the common occurrences of a mine requires immediate application of practical and efficient remedies. It will be impossible to prevent accidents altogether owing to emergencies over which there are no practical control. Yet, no doubt, there is room for amendments, which can only be accomplished by the cooperation of the ordinary miner and the mining officials.

The largest percentage of accidents are due to falls of roof in the mine. This is a subject which of late has been specially investigated, and it still demands more investigation and consideration of mine officials and workmen. To guard against these accidents it requires careful watchfulness both by the officials and workmen. In some mines a system has been adopted by which the distance apart of supports are kept in a methodical manner, the distance being determined by the general condition of the strata. But this system is open to objection, as regards setting supports at stated distances under all circumstances. This would not be trustworthy in the neighbourhood of slips, joints, etc. Hence, to obtain a maximum amount of safety regarding the supporting of the roof of a mine it will be necessary to have at hand a good supply of timber. The widest span of supports may be determined, but in the neighbourhood of slips, joints, and faults, which have been detected by a careful examination, the position and distance apart of supports could only be determined on the spot. Carelessness and wilful neglect of workmen in putting in sufficient supports and at the proper time (where workmen chiefly timber) should be guarded against by so determining agreements that it is of no advantage to them to be careless and indifferent regarding the safe supporting of the roof of their places. A proper examination of all parts of the roof should be made so as to detect any breaks, joints, or loose rocks which may be suspended after the firing of shots. Where safety lamps are used an important item in their construction to be considered is their luminosity; also the C.M.R.A. and Special Rules should be complied with.

Explosions stand next to falls of roof for causing a large percentage of fatal accidents, the percentage as given in the reports being ·291 per 1,000. But modern researches have brought to light a co-worker with fire-damp in the devastating power of an explosion, namely, coal dust, which in itself is an explosive agent, and should be treated as such by introducing precautionary regulations. There is no doubt but that the State Regulations will soon be amended and adapted to the advancement of modern scientific knowledge, especially regarding the subject of coal dust and the use of gunpowder in mines. That coal dust is in itself an explosive agent has been thoroughly and adequately proved beyond doubt by the labours of our mining engineers, inspectors, and other scientists. Donald M. D. Stuart, Esq., gives the theory a thorough trustworthy basis by his excellent treatise on coal dust as an explosive agent, his groundwork being taken from an actual occurrence of an explosion at the Camerton Collieries, which was asserted to be entirely free from the presence of fire-damp.

That gunpowder is also a contributor to the fatal accidents in mines is very apparent. Much has been said on the use of gunpowder in fiery and dusty mines, and no doubt some legislative action will very soon be taken regarding its use in mines. Taking into consideration the advancement of higher explosives as regards their safe and efficient application to blasting in mines, and at the same time noting the dangers incurred by the use of gunpowder in dusty and fiery mines, the total abolition of gunpowder from these mines seems to be the only adequate resource which will deal with the problem. From late experiments and facts produced by some of the inspectors of mines it may be asserted that gunpowder is responsible for the majority of accidents connected with the use of explosives in coal mines, and that gunpowder shots (especially blown out shots) are responsible for causing explosions of fire-damp or coal dust.

Accidents in shafts are also a source of increasing to a large extent the death-rate, but considering the dangerous work of those employed in shafts the only recommendation perhaps that can be given would be the engagement of men who are steady and who understand their work thoroughly. The material used should be strong enough to meet any emergency which is likely to take place, and the examining of the shaft and the appliances connected are also important items.

The foregoing are, no doubt, the main sources to which fatal accidents are due, yet, a large number of other fatalities occur which are placed under the head of miscellaneous. Many of these are due to carelessness and open rejection of the laws and regulations laid down for the proper management of mines, and as soon as these are thoroughly understood both by workmen and officials then we may expect a reduction of these accidents. A large percentage of the accidents may be traced (by examining inspectors' reports) to the utter refusal of complying with the C.M.R.A. General and Special Rules.

MYLES BROWN.

ERRATA TO VOL. II.

In Competition Questions 3 and 4, page 296, Vol. II., for CH^4 read CH_4; for CO^2 read CO_2; and for the *atomic* weight of CO_2 read *molecular* weight.

On page 295, instead of the pressure of the atmosphere is 15lbs. to the square *foot*, read to the square *inch*.

N.B.—If any of our readers are aware of other misprints or mistakes in Vol. II., which have not been previously corrected, we would be pleased if they would communicate with us so that we may have them correcte d.

ANSWERS TO CORRESPONDENTS.

RECEIVED :—Science Progress (Monthly, 2/6. The Scientific Press, Ld.) Report of the Proceedings of the Flameless Explosives Committee, North of England Institute of Mining and Mechanical Engineers. Electric Motive Power, by Albion T. Snell.—Will review these next issue.

CANDIDATE.—The ventilation plan given at the Manchester Examination, 1890, showing a method of ventilation, appeared in No. 3, Vol. II ; that given in 1892 also ventilated in No. 26, Vol. I ; that given in 1893 appeared in No. 3, Vol. III (special number, 2d,), and we will endeavour to publish that given in 1891 in an early issue.

ANXIOUS.—You cannot expect to receive the criticism of the ventilation plan by return of post. We have had a considerable number to examine and we wished to return the whole at the same time. We are pleased at the manner in which our readers have received our new educational departure.

EDITORIAL CHAT.

THE harrowing details of one colliery calamity has scarcely been fully realised by the country in general before another occurs, equally disastrous in its effects ; we refer to the flooding of the Diglake Colliery, Audley, North Staffordshire. It is not our intention to give the particulars of this catastrophe, as a full description will already have been seen by our readers in the newspapers, but the bitter lesson which such an occurrence teaches us cannot pass unmentioned. It is only by such dire and destructive occurrences that some men can be argued into believing the necessity of certain precautionary measures, and it is a fact, deplorable though nevertheless true, that there are many miners even in this enlightened age who consider surveying a needless and unnecessary item in the working of a colliery. The absolute necessity for *correct* mine plans should now be apparent to everyone, and, thanks to the C.M.R.A., there will be less risk of such an accident happening, either by ignorance or carelessness in future years.

From the accounts given of the fatality in question, it appears that the colliery being worked was in close proximity to some old workings, and it was thought advisable that a barrier of coal, of considerable thickness, be left between the new and the old workings, to prevent the influx of any water which might have accumulated. But owing to the inaccuracy of the information obtained of the old workings, what was thought to be an adequate and safe barrier was only a few yards in thickness, and, as a natural consequence, the heavy pressure of water formed a breach in the weak barrier and rushed with terrific force through the workings of the Diglake Colliery, and entombed a large number of men. When a large number of lives are lost, as on the present occasion, one cannot refrain from considering what precautionary measures would have prevented such wholesale destruction. A correct mine plan of the old workings would, under ordinary circumstances, have saved these men's lives.

The provisions and enactments of the C.M.R.A., with reference to the approaching of old workings, seem to be inadequate, as will be seen by the Act, which is as follows :—*Where a place is likely to contain a dangerous accumulation of water, the working approaching that place shall not at any point within forty yards of that place exceed eight feet in width, and there shall be constantly kept at a sufficient distance, not being less than five yards in advance, at least one borehole, near the centre of the working, and sufficient flank-boreholes on each side.*

The above is all that is required if the position of the old workings is correctly known, but if the plans are a good many years old and there is nothing to vouch for their accuracy or completeness, then the boreholes should be commenced, when the probable distance from the old workings is considerably in excess of that required by the Act.

As our readers are aware, in No. 1, of the present volume, we published an editorial criticism on the Colliery Managers' Examinations, and we are glad to see it has received due attention in the proper quarter. We have given an impetus to the subject, which appears to be growing, as it was discussed with much interest at a meeting of the Lancashire Branch of the National Association of Colliery Managers. Mr. F. Brain, the president, in his address, spoke at length on the desirability of uniformity in the conditions and requirements of the examinations, which was unanimously agreed to by the members, and the Executive Council of the Association was trying to arrange for a deputation to meet the Home Secretary on this important subject. Mr. F. Brain, communicated with us a few weeks ago with reference to our criticism, and it is evident he agreed with the general tenor of it at least, and we are pleased that he has taken active steps to bring about the desired changes.

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No. 16. Vol. III. SATURDAY, FEBRUARY 9, 1895. FORTNIGHTLY. ONE PENNY.

CONTENTS.

EASY LESSONS ON MINE SURVEYING

For Beginners.

Commenced in No. 2, Volume II.

LEVELLING.—Continued.

THE rise or fall of the point H (fig. 95*) is next required, and the manner of calculating it must be carefully remembered by the student, and is as follows:—The difference between the reading at that point and of the *backsight* is taken, and the result recorded as a rise or fall according as the backsight is greater or less. Thus in the example the reading of H is 2·86 and that of the backsight immediately preceding is 5·76, therefore there is a rise at H of $5{\cdot}76 - 2{\cdot}86 = 2{\cdot}90$. The calculation for each of the following sights is taken in relation to the one preceding as before, and presents no difficulty. The advantage of adopting a datum line of several feet below the first sight when calculating the reduced levels will be apparent in the above example. If the reduced level of A was taken at 0·00, that of B would be minus 2·34. For, to ascertain the reduced level of a point with a fall, the amount of fall must be subtracted from the preceding reduced level. If there is a rise it must be added to the preceding reduced level. The reduced level of C would be $-2{\cdot}34 - 1{\cdot}10 = -3{\cdot}44$, and that of D would be $-3{\cdot}44 - 6{\cdot}26 = -9{\cdot}70$. These minus signs would create errors besides being inconvenient to plot, and are obviated by taking a datum line which will be below the lowest point of the survey.

The curvature of the earth's crust renders it necessary to make a correction when long sights are taken. The correction for the curvature of the earth for one mile is 8 inches, but the refracting action of the air reduces the correction to be made to 6·9 or about 7 inches. It will be apparent that for ordinary sights under 150 yards in distance the correction is too small to require attention.

The levelling staff by which the heights are read off by the instrument, is so constructed and graduated that the observation can be made by the observer to a very small fraction of a foot. The staff (fig. 97) most commonly used is about 14 feet long, and consists of three parts which slide one within the other, so that it may be reduced to about 5 feet 3 inches in length for convenience in carrying, and the lower portion is about 3 inches broad by 1½ inches deep.

The levelling staffs used underground are of necessity very much smaller than those used on the surface, a convenient size being a 6 foot staff to close down to 2 feet 6 inches. Gee's staff (figs. 99 & 100) as manufactured by Messrs. DAVIS & SON, is a convenient form for levelling underground and facilitates the work. As the heights of the roads vary considerably underground, it is sometimes possible to take a reading almost to the full height of the staff, while at other times the height does not allow of either of the sliding portions being opened out. If the ordinary staff is used a reading cannot be taken to one of the upper parts without this

* See last issue.

portion is opened out to its full extent as the reading would not be continuous, but as is often the case resource is had to "rule of thumb" calculations, which very often cause errors. To obviate this difficulty, Gee's staff is so designed that by means of a band passing over a roller on the top of the sliding piece, a continuous reading may be taken even when the sliding portion is only partly raised.

The manner in which staffs are graduated is shown by the enlarged sketch (fig. 98) of a

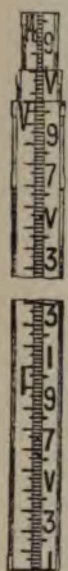


Fig. 97


Fig. 98


Fig. 99


Fig. 100

portion of the staff. The face is divided into three longitudinal columns, the central of which is graduated to hundreths of a foot, each graduation being represented by alternate black and white divisions, so that they may be read at a considerable distance. The feet are denoted by large red figures in the left-hand column, and the tenths of a foot by odd black figures on the right-hand column. The even numbers are omitted so that the other numbers may be made as large as possible. The numbers denoting the tenths of a foot are exactly opposite to the division to which they relate, so that if the cross-hair of the level cuts some portion of the three-tenths division, the reading is ·2 + and not ·3 + To facilitate the reading still further every alternate five-hundreth of a foot is denoted by a black diamond as shown in the right-hand column.

The student will find no difficulty in reading off any point of the staff in the ordinary way, but the lens of the level give an inverted image of the staff and all other objects, and the reading is apt to be made incorrectly by the beginner if considerable care is not taken, but a little experience is all that is necessary for the observer to become accustomed to the inverted appearance of the staff. On Gee's staff the numbers are inverted to facilitate the reading as shown in the illustration.

It is highly essential that the staff-holder should keep the staff in a truly vertical position, while an observation is being taken, and also to retain the staff on the exact spot during the changing of the instrument from one position to another, as these are the greatest sources of errors in levelling, providing the levelling instrument is in proper adjustment.

Plotting the Levels.

To plot a series of levels a line is drawn on the paper to represent the datum line, and along this line the horizontal measurements are marked off to denote the points at which the levels were taken. The measurements may be taken in separate lengths for each level, but if the levels are in a continuous length, the measurements may be read off so as to form one total distance as in the examples given. From the points marked off, lines are drawn at right angles to the datum line to represent vertical heights, and the heights given by the reduced levels are measured off. Lines are then drawn joining the points thus obtained, and we have a plotted section.

The vertical heights are usually plotted to a larger scale than the horizontal distances, so that the various inclinations may be more clearly defined. As an example of how the levels are plotted take the reduced levels and distances given below. It must be understood that the heights given are not those read off by the instrument, but those calculated to a datum line, or as we have termed them reduced levels. (See previous articles.)

Reduced levels in feet.	Distances in feet.
59·1	0 at A.
50·5	68
54·0	118
66·4	198
56·5	261
50·3	302
38·0	356
31·0	401
27·3	472
34·5	540 at B.

The above level survey is shown plotted by fig. 101. The datum line is first drawn and the measurements are marked off to a scale of 180 feet to an inch, and lines are drawn at right angles from these points, and the heights are marked off to a scale of 60 feet to an inch. The extremities of these lines are then joined, and the section is shown by the firm line.

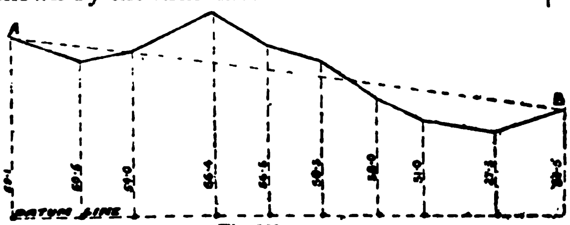


Fig. 101

If the inclination of an imaginary line A B (shown dotted) was required, the height of B is deducted from A, and the difference is divided into the distance between the two points. Thus $59\cdot1 - 34\cdot5 = 24\cdot6$, and assuming that the measurement, 540 feet, is in a straight line $\frac{540}{24\cdot6} = 22$ nearly.

That is, a roadway driven from A to B would incline at the rate of 1 in 22 nearly. The inclination of the line on this figure is greater than this, because the section has not been drawn to a natural scale; but this has nothing to do with the actual facts of the case. We have mentioned it to prevent the student from misconstruing our remarks.

(To be continued.)

Colliery Managers' Examinations.—Sixteen of the successful candidates in the First-Class Exam., and nine of those in the Second-Class Exam., held at Manchester, in December last; and two successful in the First-Class and six in the Second-Class, held at Glasgow, in Nov. last, are students of the Universal Mining School, Derby, conducted by Mr. T. A. Southern, late H.M. Inspector of Mines. Three candidates passed the First-Class Exam. for the Bristol district, held at Newport, in September last; the announcement in one case was delayed until recently, pending a decision of the Home Secretary; two of them are students of the Universal Mining School.

VENTILATION.

By JOSEPH CARTER, First-Class Certificated Manager.

THE following rules and examples relating to calculations on ventilation will be found of the utmost service, and students of "Mining" will do well to work out similar examples for themselves.

The quantity of air passing in airways of different areas (other things being equal) is according to the square root of the area multiplied by the area.

Example I.—What quantity of air will pass through an airway of 25 square feet area when 20,000 cubic feet passes through one of 64 square feet area? Pressure and rubbing surface being the same in each case.

$$\frac{\sqrt{25} \times 20000}{\sqrt{64}} \times \frac{25}{64} = 5208\cdot3 \text{ cubic feet.}$$

The quantity of air passing is according to the cube root of the power applied, and the power according to the cube of the quantity.

Example II.—If by employing 64000 units of work we get 16000 cubic feet of air, how much shall we obtain by employing 216000 units of work?

$$\frac{16000 \times \sqrt[3]{216000}}{\sqrt[3]{64000}} = \frac{16000 \times 60}{40} = 24000 \text{ cu. ft.}$$

In making calculations students must not confuse pressure with power, but must clearly understand that pressure is the force per square foot producing the ventilation, and power is the quantity passing multiplied by the pressure.

The following rule is used to make airways of different lengths of such areas as to pass an equal quantity with the same pressure:—

$$A = \frac{q}{\sqrt[3]{\dfrac{u}{k s}}}$$

Where A = Area, u = Units of work, q = Quantity, k = Co-efficient of friction, s = Rubbing surface

Example III.—Find the areas of each of the following airways to pass the same quantity of air through each with the same pressure.

A mine is ventilated by four different splits—

The first	200 feet long	and 10	feet area.
,, second	300 ,,	?	,,
,, third	400 ,,	?	,,
,, fourth	600 ,,	?	,,

We may in this question cancel the following, quantity (q), power (u), and coefficient of friction (k), as they are the same in each case, therefore the above formulæ will then be reduced to $\sqrt[3]{s}$ that is, the area will be according to the cube root of the rubbing surface. We may consider this to be the length, because the perimeters are all equal, so that the results will be as the cube root of the length.

$$(1) \quad \sqrt[3]{200} = 5{\cdot}84803$$
$$(2) \quad \sqrt[3]{300} = 6{\cdot}69433$$
$$(3) \quad \sqrt[3]{400} = 7{\cdot}36806$$
$$(4) \quad \sqrt[3]{600} = 8{\cdot}43433$$

We now proportion them as follows :—

5·84803 : 10 :: 6·69433 : 11·44 area of 2nd airway.
5·84803 : 10 :: 7·36806 : 12·59 „ 3rd „
5·84803 : 10 :: 8·43433 : 14·42 „ 4th „

Example IV.—We have 20000 cubic feet of air passing round a mine in one current, area of air-way 30 ft., rubbing surface 20000. What quantity of air will circulate when the current is split into 2, 3, 4, 5, 6, and to 10 divisions, pressure remaining same ?

The effect of splitting here is double, treble, &c., of the area without altering the rubbing surface, and the quantity is obtained by rule $\sqrt{\frac{p\,a}{k\,s}} \times a$. This is used to find the different quantities of air in the various splits in operation, but as p, k, and s are the same in each case, we can cancel them and reduce it to this simple rule $\sqrt{a} \times a$, and the relative quantities will be according to the square root of the area multiplied by the area.

These may be found simply as below :—

$\sqrt{1} \times 1 : 20000 :: \sqrt{2} \times 2$: 56568 for 2 splits.
$\sqrt{1} \times 1 : 20000 :: \sqrt{3} \times 3$: 103923 for 3 splits.
$\sqrt{1} \times 1 : 20000 :: \sqrt{4} \times 4$: 160000 for 4 splits.
$\sqrt{1} \times 1 : 20000 :: \sqrt{5} \times 5$: 223607 for 5 splits.
$\sqrt{1} \times 1 : 20000 :: \sqrt{6} \times 6$: 293938 for 6 splits.
$\sqrt{1} \times 1 : 20000 :: \sqrt{7} \times 7$: 370405 for 7 splits.
$\sqrt{1} \times 1 : 20000 :: \sqrt{8} \times 8$: 452548 for 8 splitf.
$\sqrt{1} \times 1 : 20000 :: \sqrt{9} \times 9$: 540000 for 9 splits.
$\sqrt{1} \times 1 : 20000 :: \sqrt{10} \times 10$: 632456 for 10 splits.

(In the above shaft resistances are not taken nto account.)

Now if the power is to remain the same instead of the pressure the result would be considerably altered, because they would simply be in direct proportion to the area—1, 20000; 2, 40000; 3, 60000; and so on to the 10th.

There is a wide difference between splitting the air and making an additional airway of the same length and area as the original one; this may be found as under.

Example V.—If an airway passes 20000 cubic feet of air through it, what quantity will pass by making an additional airway of same size and length as the other one ?

$$\sqrt[3]{\frac{1}{1}} \times 1 : 20000 :: \sqrt[3]{\tfrac{1}{2}} \times 2$$
$$= 1 \times 1 : 20000 :: \sqrt[3]{\cdot 5} \times 2$$
$$\therefore 1 : 20000 :: \cdot 7937 \times 2 : 31748 \text{ cubic feet of air.}$$

COMPETITION QUESTIONS.

No. 9 SET.

To the sender of the best set of Original Answers in each Stage will be awarded the following :—

Elementary 2s. 6d., Advanced 3s. 6d., First-Class 4s. 6d.

A Competitor may only answer one Stage in each issue, though a different Stage may be taken in another issue. The best answer to each question will be published with the sender's name and address.

1.—All envelopes must be marked "COMPETITION."

2.—To be written on separate sheets of paper with name attached, and on one side of the paper only. Sketches to be in ink on *unruled* paper.

3.—Correct name and postal address must be sent.

4.—They must reach us by February 22nd, 1895.

5.—The Editor's decision as to winners to be final.

ELEMENTARY.

Question 1.—How is water dammed back in shafts by metal tubbing ? Give particulars with sketches of a segment of tubbing. What is the usual thickness of the metal employed ?

ADVANCED.

Question 2.—Describe in detail the Kind Chaudron method of boring and lining shafts in watery strata. Give sketches.

FIRST-CLASS.

Question 3.—Describe with neat sketches the necessary fittings for a Lancashire boiler.

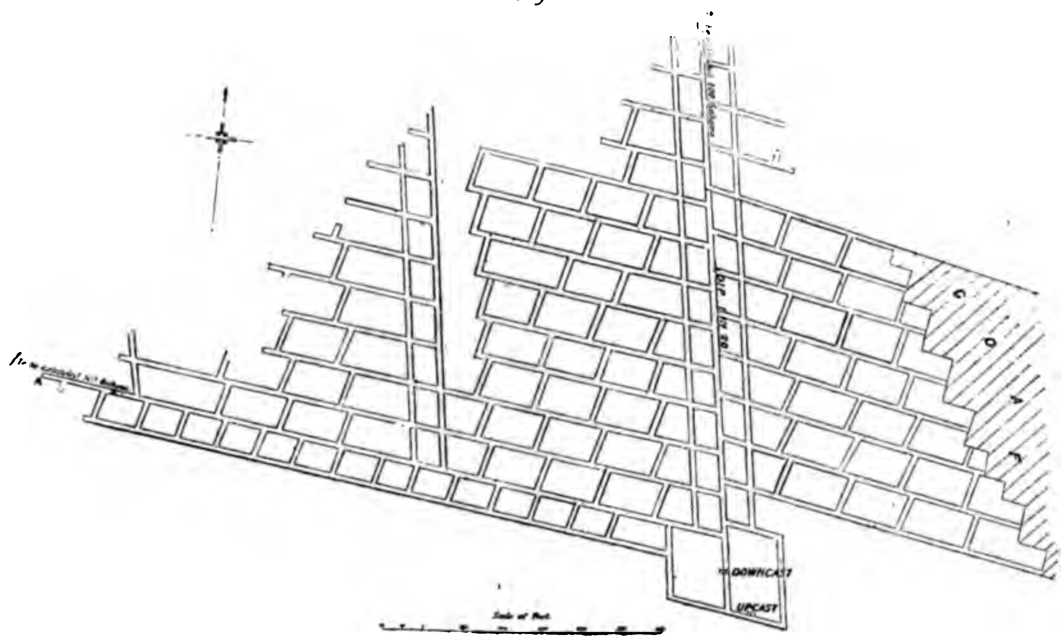
Question 4.—How would you prepare for a thorough inspection of a Lancashire boiler, and to what points would you more especially direct your attention ?

For particulars of Gold Medal and other Competitions see No. 23, Vol. II., to No. 1, Vol. III.

VENTILATION PLAN

Given in West of Scotland District Examination for First-class Certificates of Competency.

1891.



The plan shows stoop and room workings in a 6 feet seam. Show on the plan how you would ventilate them so as to allow naked lights in the solid places, with safety lamps in the stooping and level A?

Students Method of Ventilation Criticised.

We will criticise a student's attempt at ventilating the above plan, and return him plan correctly ventilated for a nominal charge of 6d.

The following conditions to be observed:—

(1) The student's name and address must be written on each plan sent.

(2) Plans to be sent before February 16th.

The corrected plans will be returned the following week.

The plan given in No. 3, Vol. III., may still be criticised and a corrected plan returned at a charge of 9d.

It is evident our new and unique educational departure has hit the wants of a large number of readers, for the simple reason that it is a subject which students find very difficult to learn without the aid of a teacher. Unless a student has made frequent efforts beforehand to ventilate a plan, his answer to that most important question at an examination will be a sorry one. Even if he attempts to ventilate numerous plans his general principle may be wrong, and unless he has someone to guide him he is as far off as ever.

We assert that if a student who possesses an elementary idea of mine ventilation attempts to ventilate the plans which we give from past examinations, and takes full note of our criticism and corrected method of ventilating same, after five or six attempts he should be capable of satisfying the examiners in that question at least.

Several of the numerous readers who sent in the plan, which appeared in No. 3, have already testified to the efficiency of our criticism.

Accidents in Mines.

The summary of accidents in mines has just been published for the year 1894, the number of separate accidents in and about coal mines being 813, causing 1,127 deaths. We will give details of the above in an early number.

EXPLOSIVE EXPERIMENTS

Near Wigan.

(COMMUNICATED.)

ON Wednesday, the 30th January, a series of interesting experiments were carried out with the new explosive, Westphalite, at the Works of the Roburite Explosives Co., Limited, Gathurst, near Wigan. All the shots were fired by electric detonators in an untamped condition from a cannon sunk vertically in the ground. Above the cannon was an iron cylinder of 56 cubic feet capacity, into which was led a feeder of coal gas. This cylinder before each experiment was closed by a paper covering, and gas admitted so as to form an explosive mixture of gas and air. The following are the results recorded: With gunpowder an explosion of gas took place. With Westphalite, using a No. 6 detonator, a loud report was heard, but no ignition of gas occurred. On examining the inside of the apparatus a considerable quantity of unexploded Westphalite was found in the cannon itself, and scattered about in the tank, showing incomplete detonation. With Westphalite, using a No. 7 detonator, the gas was exploded each time, and in some cases the feeder conveying the gas was lit. Various weights of cartridges, namely, 4oz., 8oz., and 12oz. were tried, with similar results.

The above experiments confirm the opinions as stated by the Roburite Explosives Co., viz.:—(1) That when Westphalite is fired with a No. 6 detonator only partial combustion takes place, and the gas is not fired. (2) That when Westphalite is completely detonated, ignition of a mixture of gas and air invariably occurs. The Company further state that Westphalite when completely detonated appears to be more fiery than any other of the Sprengel explosives. Experiments were afterwards made with explosives of the nitro-glycerine class, showing the danger of introducing the carbonic oxide gas (CO) into a dusty atmosphere. A cartridge of carbonite was fired in a bomb, the resultant gases collected, and mixed with air and coal dust. On applying a light the mixture burst into flame, the coal dust burning furiously under these conditions. Carbonite gives off a large percentage of the poisonous gas, carbon monoxide, and the fumes so formed will readily form an explosive mixture with air and dust.

SUMMARY OF THE

MINERAL PRODUCE OF THE UNITED KINGDOM AND ISLE OF MAN, 1893.

Description of Mineral.	Quantity.	Value at the Mines and Openworks.
		£
Alum Clay (Bauxite)	8,740	4,150
Alum Shale............	2,115	264
Arsenic	5,976	57,694
Arsenical Pyrites ...	3,036	2,948
Bareytes	22,343	25,363
Bog Ore	10,747	2,686
Clays (excepting ordinary clay)......	3,066,208	817,419
Coal	154,325,795	55,809,808
Copper Ore............	5,346	12,961
Copper Precipitate...	230	2,210
Fluor Spar	215	161
Gold Ore...............	4,489	7,657
Gypsum	143,486	59,369
Iron Ore	11,203,476	2,827,947
Iron Pyrites	15,837	7,292
Jet........................	188	177
Lead Ore...............	40,808	280,539
Lignite..................	3,264	816
Manganese Ore	1,336	762
Ochre Umberete ...	10,534	13,880
Oil Shale..............	1,956,520	489,130
Petroleum	260	488
Phosphate of Lime...	3,300	5,771
Salt	1,924,029	735,222
Slates and Slabs... ..	438,993	1,107,626
Stone, &c.	—	7,773,743
Strontra Sulphate ...	5,812	2,325
Tin Ore	13,689	637,053
Uranium Ore	25	500
Wolfram	22	420
Zinc Ore	23,754	81,270
Total value.........		£70,767,651

AWARDS

FOR ANSWERS TO COMPETITION QUESTIONS.—No. 6 SET.

ELEMENTARY.—Jos. Wheatcroft, 8, Longsight Terrace, Kinsley Hemsworth, near Wakefield.

Commended.—W. H. Hardy, M. Collinson, F. Cherry, T. Webster, J. H. Annable, J. H. Senior, T. Williams, T. Henry, J. Finch.

ADVANCED.—Joseph Crone, Chowden New Houses, Low Fell, Gateshead.

Commended.—W. Slocombe, H. Hall (Ryhill), J. Stephenson.

FIRST-CLASS.—Geo. Daykin, 24, High Guerney Villa, Bishop Auckland.

Commended.—M. Brown, J. Jackson, J. Harrison, J. Davies.

THE ATMOSPHERE.

By MYLES BROWN.

(CONTINUED FROM NO. 4).

AN interesting calculation may be worked out by finding the pressure of the atmosphere on a man of average build, the result will be about 15 tons, yet, being equalised, it is not ielt; the fact that air has weight has been known a long time. Like all other forms of matter, air is acted upon by the laws of gravitation, which produces the pressure as afore-mentioned, namely—14·7lbs. per square fnch. Galileo was the first who discovered that air is subject to the great law of gravitation and has weight. Torricelli, a pupil of Galileo, followed up these researches, and in 1643, demonstrated that the atmosphere has weight, and exerts a pressure upon the surface of the earth; and he also discovered how to measure the pressure; in experimenting to prove this, he constructed the first barometer. A barometer consists of a glass tube about 36 inches in length; the glass tube contains mercury, which is subject to the pressure of the atmosphere at the lower end of the column. Mercury is used to denote the pressure owing to it having a high specific gravity, namely—13·6. In constructing a barometer a certain quantity of mercury is placed in the tube, which is then inverted into a cup; a vacuum is effected at the higher end of the tube, thus the higher end of the column of mercury is not subjected to any pressure. The column of mercury varies in length according to the variations in the atmospheric pressure; a scale is attached to the glass tube to denote the height of the column of mercury, also a vernier is attached to show the height to the hundreth part of an inch. The pressure of the atmosphere in pounds per square inch may be calculated by multiplying the height of the column of mercury in inches by ·4908, this being the weight of a cubic inch of mercury. The following rule applies to the barometer:—"The height of the barometer increases as we descend, and decreases as we ascend." The column varies one inch for about every 900 feet difference in level, thus the heights of mountains and the depths of shafts may be roughly calculated by the barometer. The variations of the atmospheric pressure influences the gases contained in mines; hence we find a barometer fixed near the entrance to every mine as required by Act of Parliament. The roadways of a mine are fouled by the issuing of gases from the goaves and the strata, coincident with a falling barometer; this is caused by a reduction of pressure. The pressure exerted by the atmosphere is an important factor as regards the operation of many appliances and arrangements, which depend for their motive power on the weight of the atmosphere. The most important and perhaps the most interesting appliances to the readers which embrace the principle of air having weight and thus exerting pressure, will be the example of the pump and the syphon; the syphon depends alone on the atmospheric pressure, and no doubt, it is one of the most effectual and efficient appliances which depend for their motive power on the atmosphere. The atmospheric pressure should force or lift water to a height of 34 feet theoretically, but in practice the lift does not exceed 28 feet.

NATURE PURIFIES THE AIR BY VARIOUS PROCESSES.—The process most interesting as well as important to the mining student is that of diffusion, a property of gases by which the composition of the air is kept almost constant, all gaseous impurities being evenly spread throughout the atmosphere. The growth of vegetation is an important purifier of the atmosphere, as it imbibes the carbon dioxide, which is so injurious to animal life, then the more vegetation and plant life the better. Rain is also a purifying agent, owing to it washing the air in its descent to the earth; and lastly there is the agent of oxidation slowly carried on by the oxygen of the air.

THE VARIATIONS IN THE ATMOSPHERIC PRESSURE—causes the boiling point of a liquid to vary. In mountainous districts a sufficiently high boiling temperature cannot be obtained for the proper cooking of food in an open pan where ebullition must take place at the ordinary pressure of the atmosphere; hence the appliance known as *Pappin's Digester* is employed, which is a light copper vessel, constructed with a safety valve to secure a pressure greater than that of the atmosphere.

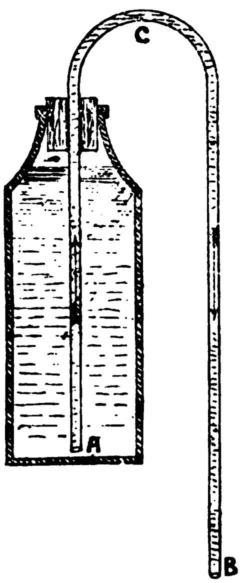
The true definition of the boiling point of a liquid is:—That point of temperature at which the tension or elastic force of its vapour is exactly equal to the pressure it supports. The enormous power of air in motion is shown by the great havoc caused in many parts of the globe by cyclone storms, and then there is another instance of the awful havoc and power of air in motion when an explosion takes place in a mine in which the current is restricted to narrow limits.

New use for Air.—"If all the air in the room in which I am now sitting," said a chemist, "was subjected to a temperature of 180 degrees Centigrade below zero, the result would be a drop of bluish liquid. This drop suddenly exposed to heat would explode like dynamite."

Frost is just as severe as heat. A drop of air at a temperature of minus 180 degrees Centigrade would freeze a hole through a person's hand, as effectually as the same quantity of molten lead or steel would burn it through.

In conclusion, perhaps it will be wise to describe a simple experiment, which any novice may try, and by which the actual principle of the air may be clearly demonstrated, this will do more to impress thoroughly the principle of air upon the mind of the student, than pages of reading.

Experiment.—This experiment illustrates the action of a syphon, and also shows that the working of the syphon depends alone on the pressure on the atmosphere. An idea used to be prevalent that it was suction and not pressure which caused the syphon as well as the pump to work. To prove the fallacy of this idea we will adopt the experiment as shown in sketch. In the first place, press the cork or stopper into the neck of the bottle so as to prevent the pressure of the air coming in contact with the water in the bottle (A), having done this connect the end of the tube (B) to an air-pump, or simply place it in your mouth and inhale, by so doing a partial vacuum is produced in the tube (B), this being essential for the starting of the model syphon. The result produced by the foregoing will be that no water can be displaced from the bottle. Now after having done this, ease the cork or stopper, which will allow the atmospheric pressure to come in contact with the water, the result will be, that after having produced a partial vacuum in tube (B), the water in the bottle will flow out at the end of the tube (A) until the bottle is emptied. (*Concluded.*)



ANSWERS TO QUESTIONS

No. 6 Set—In No. 3, Vol. III.

ELEMENTARY.

POSITION, FORM, ETC., OF SHAFT.

Question 1.—How would you determine the following preliminary operations to sinking, viz.:—position, form, size, and marking out of shaft?

Answer.—Position. Both the probable underground conditions and the surface arrangements must be taken into account to decide the position of the shafts for a new winning, and if the advantages accruing from a certain position in each case are not coincident, then a compromise must be effected according to the relative advantages of each. The underground conditions to be considered are probable amount of water to be dealt with, haulage, and extent of royalty on each side. If a considerable quantity of water is to be expected an advantage would be gained by having the shaft to the dip, as it would also facilitate the haulage; and the shaft should be so placed on the dip that an equal area of coal would be worked to the right and left. The extra cost of sinking the shaft on the extreme dip, however, impels some managers to adopt a middle course and leave a considerable area of coal on the lower side, especially is this the case if the seams are dry. The principal surface consideration is the cheap disposal of the coal, and it is advantageous to sink the shaft near a highway, railway, or waterway, as the case may be.

Form. There appears to be no question as to the circular being the best form of shaft for collieries, at least in Europe, as it is almost universally adopted, except in Scotland. It is the strongest, cheapest to sink, and the best for damming back water and for ventilation. When wood is abundant and cheap the rectangular shape is generally adopted, as it is the easiest form to secure with timber.

Size. The size of the shaft depends upon the purpose to which it is to be put, whether for pumping, winding, ventilation, or all combined. If the shaft is to be used for winding, the required output and the size of the tubs decide the dimensions of the cage. To ascertain the required diameter of a shaft for one cage plot the dimensions of the cage to a definite scale, on paper, as shown by fig. 1. Draw diagonals of the rectangle thus formed, and from the point of intersection draw a

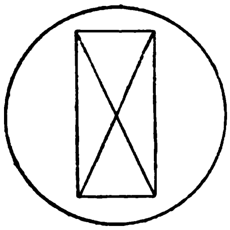


Fig. 1

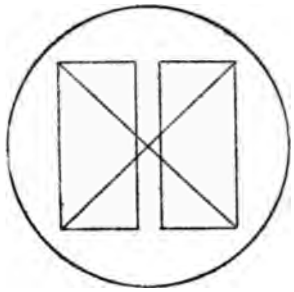


Fig. 2

circle so that the clearance at the corners of the rectangle will be from 3 to 9 inches (according to the depth of the shaft and the kind of guides to be used). Now measure the diameter of the circle with a scale, and the required diameter of the shaft will be obtained. If two cages are to be run in the shaft, two rectangles must be plotted from 9 to 18 inches apart for clearance, and the extreme corners joined, as shown in fig. 2. From the point of intersection a circle is

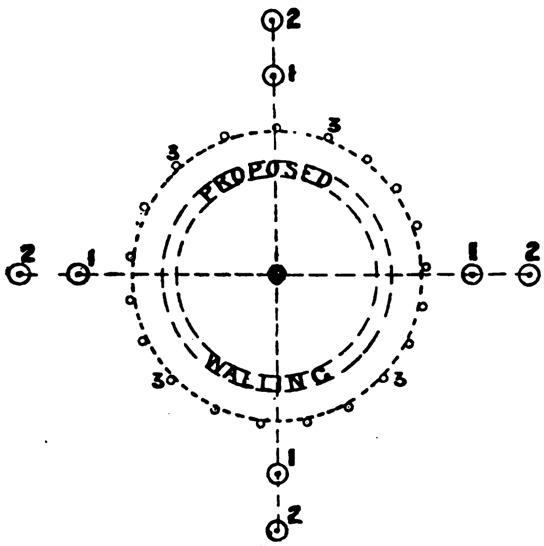


Fig. 3

drawn as before, allowing clearance space at the corners, and this gives the diameter of the shaft. Pumps, steam pipes, haulage ropes, etc., are sometimes placed in the winding shaft, and add very little to the required diameter of the shaft, as they fit in the segments of the circle left on the sides of the cages. It is desirable, however, to have plenty of space in a shaft if it is to be used for various purposes, and a considerable margin should be made in excess of the above rule in such cases. Shafts are seldom sunk now-a-days less than 15 feet in diameter.

Marking out. The position of the shaft being chosen a circle is marked out on the ground several feet larger in diameter than the proposed shaft by means of pegs (*3 3* fig. 3) to denote the size of excavation. If it is required to sink the shaft exactly in a certain position, to meet with some special surface or underground conditions, the centre *O* is first determined, and two lines are staked out at right angles to each other and four or eight pegs are inserted as shown at *1* and *2*. After the centre *O* has been removed by the excavation the exact centre can be found by running two strings across from peg to peg and the point of intersection will give the centre.

———

Editor.

ADVANCED.

TIMBERING.

Question 2.—Show by sketches the method of timbering a $5\frac{1}{2}$ yard bord with a bad roof, and of timbering and pillaring (the face of a gateway and two adjoining gateways, for a distance of 10 yards back) in longwall workings.

Fig. 1

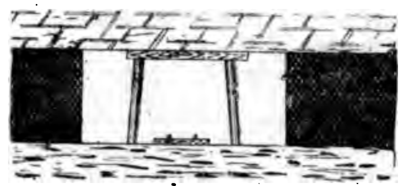


Fig. 2

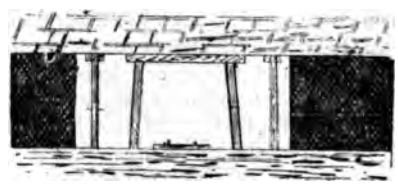


Fig 3

Answer.—In sketch No. 1, we have the method of single timbering which is sometimes adopted in a bord $5\frac{1}{2}$ yards wide, but this method is only adopted where the strata is not of any crushing pressure and where the timber has to stand only until the proper connections are made and then drawn out again to be used.

By sketch No. 2, we see the method adopted where the strata or cover is more full of partings and jacks, which cause the roof to be of a dangerous character. The timber, which is carried up the middle of the place, ought to be made as level as possible, or the tissues of the baulk or plank are so much strained that the lifetime of the same is of very short duration. There are side props and caps placed by the side of the middle timber which prevents the pressure of the strata from coming so heavy upon the middle timber under which the tubs travel, and I would place the timber in a straight line, as that zig-zag fashion of timbering, so frequently adopted, is bad in the extreme and ought never to be countenanced because of the danger and waste that always follows such timbering, and the middle timber should never be more than two feet apart from each other.

The method shown by sketch No. 3 is undoubtedly the best where the roof is bad. Instead of having the timber and the tram road in the centre of the bord I would adopt the method as shown and also resort to that of double timbering, having the timber and the tramway up one side of the bord and putting two props under the baulk end at the wide side; also placing a double prop with cap between every pair of baulks, with an additional single prop and cap by the side. The benefit realised from such method is twofold, for with the wide side being made double strong it stops the roof from coming down between the timber into the tramway, should the roof fall at the wide side. By the roof falling behind the timber at the wide side the pressure thereof is relieved and does not act with such crushing power upon the timber as in the other methods. Additional planks are sometimes put on the top of the cross ones in a running direction, which gives an extra security. No doubt more timber is used in the above method at the first placing of it, but there is less destroyed through the cover straining and breaking, hence there is less renewing or repairing to be done. When the timber has to be drawn out again there is more of it, thus effecting greater safety to the workmen and greater economy.

Timbering and Packing in Longwall.—If props should be used I would have a system and would insist upon it being carried out, namely, the props to be placed in a perfect line (as will be seen in sketch No. 4) and not to be less than, say 2 feet apart each way

Fig. 4

in the line. The first to be along the face and as near to it as possible, or it may be that two parallel rows of props are fixed, which is better, because the roof always has a tendency to break down along the face, and sometimes when a proper system is not maintained it breaks right over the coal head, crushing the coal very much and reducing its value, and it is more difficult to work for some distance again, thus causing extra expense. I would then place a row in front of the packs and another in the waste between the pack walls so as to prevent the roof from breaking down along the line of face.

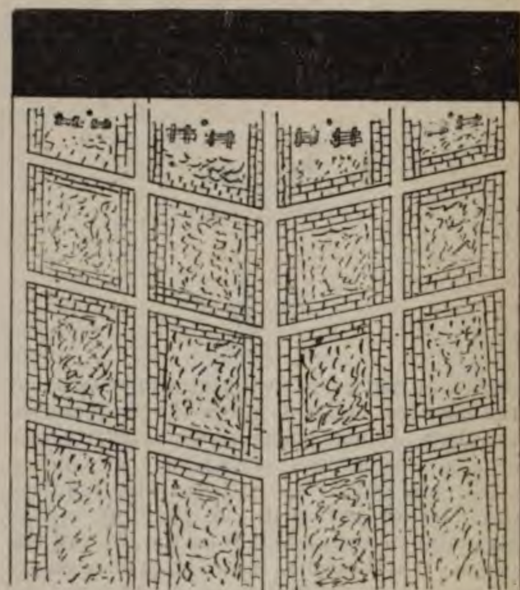


Fig. 5

The method of timbering with chocks with additional props is much better than the above. These chocks are a greater support

to the roof, consequently there is not so much danger to the workmen. On the whole a greater economy is effected by using them, because it is seldom that there are any lost, and as the face of the coal advances the chocks between the pack walls in the waste can be taken out and rebuilt near the face again. Now, as the coal face advances the pack walls should be continued parallel to each other through the goaf (as shown by sketch No. 4), the width of which should be 4 yards between for the tram roads. The width of the pack walls at each side to be 12 feet and between the goaf packs 10 yards, to be chocked as shown in sketch No. 4, the distance to be 3 feet apart each way, three rows of chocks to be used. It will be seen by the sketch given that the working is on a straight line of face. No. 5 sketch illustrates the gateways and adjoining gateways, and No. 4 the pack walls.

JOSEPH CRONE.

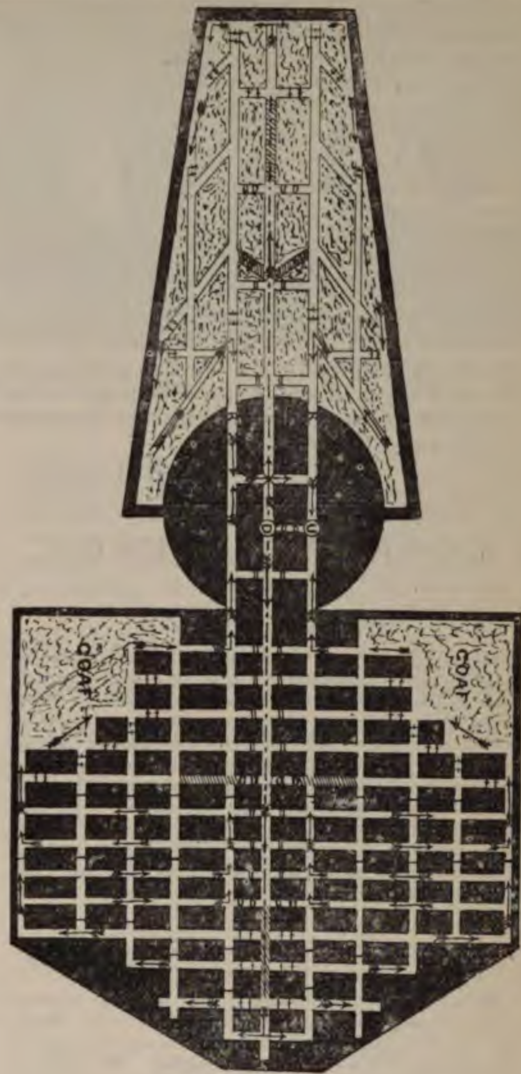
FIRST-CLASS.

METHODS OF WORKING AND VENTILATING.

Question 3.—Draw a plan showing how you would lay out the workings of a colliery for 175 hewers in each shift (*a*) Give the number of men in each district; (*b*) State the quantity of air in each split and indicate its course by arrows; (*c*) Show the position of all stoppings, crossing doors, and regulators; (*d*) Show main ways and landings.

NOTE.—One half the output to be from bord and pillar, and the other from longwall workings.

Answer.—The accompanying plan shows how I would lay out the workings of a colliery for 175 men in each shift. (*a*) On one side of the shaft the bord and pillar system of working is divided into three different districts, 30 men in each district, namely, 30 men working in the straight ahead or whole workings, and 30 men in each of the broken districts, that is, following the whole workings up and removing the pillars. The coal to the other side is worked on the longwall system, and is also divided into three districts, namely, 15 men working straight ahead and the remaining 70 men working right and left of the main haulage roads. (*b*) Before the quantity of air can be ascertained the following must be taken into consideration:—Number of boys, ponies, and lamps employed in the mine. Suppose it requires a boy for every four men, then the total number employed in the mine would be



REFERENCES.

U Upcast	X Air-crossing
D Downcart	❘❘ Brick Stopping
DD Doors	❘ Temporary Stoppings
R Regulator	†† Cloth Sheets

Direction of current shewn by arrows
Main haulage roads marked thus —— — —— —
Landings shewn by shaded portions of roadways

44 boys plus 175 men—219 persons, and say 12 horses. Mr. Fairley says "it takes 200 cubic feet of air per minute per man and 600 cubic feet for a horse to keep the mine in a good sanitary condition." To be on the safe side I will allow 200 cubic feet per minute per man, as quoted by Mr. Fairley. The quantity of air that will have to pass down the downcast per minute is as follows:—220 men and boys × 200 cubic feet of air

per minute plus 12 horses × 600 cubic feet per minute plus extra day-wage men, etc., engines, and lamps, which equals 100,000 cubic feet of air per minute, and which may be divided into nearly equal parts through the mine, seeing that both sides of the colliery employ nearly the same number of men. The direction of the air-current is indicated by arrows. (*c*) The positions of all stoppings, crossings, doors, and regulators are in accordance with the references on the plan. (*d*) The main haulage roads are in a direct line with the downcast shaft. The landings may be observed on the plan by the shaded portions of the roadway; there are three landings in the bord and pillar and three in the longwall workings.

GEO. DAYKIN.

CORRESPONDENCE.

VENTILATION QUERIES.

Sir,—Will any of your readers kindly assist me by answering the following question as plainly as possible:—The shafts of a mine are connected by three drifts, (*a*) 10 feet × 5 feet × 250 fathoms long; (*b*) 12 × 6 feet × 300 fathoms long; and (*c*) 6 feet × 5 feet × 500 fathoms long. If total quantity passing be 30,000 cubic feet per minute, how much will each split take and what will the W.G. be? In the preceding question it is desired to send 10,000 cubic feet into each split, what will be the area of the regulators in *a* and *b* in order to do this, and what will the W.G. be?—MINER.

STEAM AND THE STEAM ENGINE AND GEOMETRY QUERIES.

Sir,—I would be pleased if any of your readers would answer the following questions:—(1) Show how to take a diagram from a tandem engine and to calculate the work done by the engine. (2) What is a radian, and how many radians are there in a circle? (3) Is there any loss of power from the oblique motion of the connecting rod.—A. HART.

WHAT INSTRUMENTS ARE REQUIRED FOR DRAWING.

Sir,—Will any of your readers kindly inform me what instruments they use in drawing plans and copying sketches to illustrate Answers to Questions, as I am not a very good drawer; also state the price and where the instruments can be obtained.—A LEARNER.

BOOK REVIEW.

SCIENCE PROGRESS (Monthly, 2/6, The Scientific Press, Ld.).—We have received the January number of this magazine and the first parts of two articles, which are applied more particularly to mining, viz.:—"Coal: its Structure and Formation," by A. C. Seward, M.A., St. John's College, Cambridge; and "Folds and Faultings," by W. F. Hume, D.Sc. These are splendidly written and treat the subjects most thoroughly. The first of these, which is to be continued, reviews the three theories of the formation of coal in a very able manner. Two of the theories discussed, namely, the "*in situ*" and the "drift," are already known to our readers, but the third theory, which is simply an old one recently revised, will be new to them. To give A. C. Seward's words, "The *in situ* theory is that the beds of coal have been produced from a thick mass of vegetable *debris* which had accumulated during centuries of forest growth on the underclay surface soils; and in the stigmarias are recognised the forked roots of sigillaria stems, which largely contribute to the substance of the overlying coal." Of the drift theory the writer states, "Several writers in recent years advocated in some form or other the formation of coal strata by the drifting of the vegetable *debris* and its subsequent deposition on the floor of a lagoon or sea with an accompanying series of arenacious and argillaceous sediments." To explain the other theory, which has been resuscitated by M. Rigaud, we take the following extract from the article. "This writer's main contention is, that plants have played a subordinate *rôle* in the formation of coal, and are by no means mainly responsible for its production. Coal usually exhibits traces of plant tissues embedded in a black substance, and this homogeous matrix may be regarded either as a bituminous substance of volcanic origin, or as a product of vegetable decomposition. Assuming a tropical climate for Coal Measure times, Rigaud points out the unsuitable nature of tropical plants and the still more unfavourable climatic conditions for the formation of anything of the nature of peat. Rigaud lays stress on the absence of certain elements in the ash of coals, which ought to be present, on the assumption that the carbon has been derived from plant tissues. If coal consists of altered vegetable *debris* we ought to find a certain amount of alkalies and phosphoric acid in its ash . . . the point argued by Rigaud is one which should receive attention . . . The opaque black substance occasionally met with in the cavities of coal tissue cells is regarded by this writer as so much bituminous material, which has forced its way into the empty spaces. We have abundant evidence, he suggests, as to the eruptions of hydro-carbons in past time in the bituminous shales, asphalte, and other similar substances."

REPORT OF THE PROCEEDINGS OF THE FLAMELESS EXPLOSIVES COMMITTEE (North of England Institute of Mining and Mechanical Engineers).—This is a detail report of the Flameless Explosives Committee of the North of England Institute, to which we referred in last issue. The conclusions which this Committee arrived at will be found on page 62, No. 5, Vol. III.

ELECTRIC MOTIVE POWER (by Albion T. Snell).—This book is designed to be a practical treatise for mechanical and mining engineers and other students of Applied Electricity. The last two chapters deal exhaustively with the application of electricity to mining work, particularly with reference to collieries and coal-getting. The work is published by the Electrician Printing and Publishing Company, Ltd., Salisbury Court, Fleet Street, E.C. Over 400 pages and 246 illustrations; price 10/6.

Printed and Published by STROWGER AND SON, Clarence Yard, Wallgate, Wigan; also Published by JESSE SALISBURY, *48, Fleet Lane, Farringdon Street*, London, E.C., and JOHN HEYWOOD, Manchester.

MINING

A JOURNAL DEVOTED TO THE INTERESTS OF MINING STUDENTS

No 7. Vol. III. SATURDAY, FEBRUARY 23, 1895. FORTNIGHTLY. ONE PENNY.

CONTENTS.

EASY LESSONS ON MINE SURVEYING

For Beginners.

Commenced in No. 2, Volume II.

SETTING OUT ROADWAYS.

IT is of the utmost importance for the economic and proper working of mines that the main roads, especially haulage roads, should be kept as straight as possible. It also often happens that it is deemed necessary or advisable to drive a road or tunnel from one particular point to another to facilitate the haulage or ventilation, and the manner in which the direction of the road is determined is as follows:—Assuming the required road is one between the underground road and the shaft as shown (fig. 102). Draw a line (A B) parallel to the required road on the meridian line, which we presume to be already on the plan. Now take a brass protractor and place the N and S, or 0° and 180°, so as to coincide with the meridian line, and with its centre at the point of intersection of the meridian line, and the line A B as shown by fig. 102. The bearing of the line (A B) can now be read off from the protractor. The bearing can be found with a cardboard protractor with equal facility by placing the N and S of the protractor as before on the meridian line, next finding the centre of this line by joining the W and E points, and then through the centre thus found drawing a line parallel to the proposed road, the bearing can now be ascertained by laying a ruler or straight-edge along this line and reading off the bearing which it makes on the protractor.

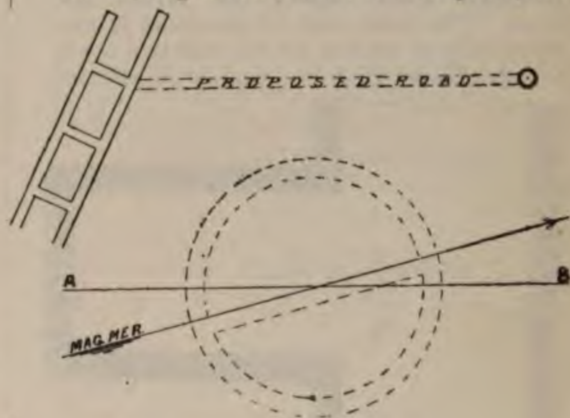


Fig. 102

Having now determined the magnetic bearing of the required road, the next consideration is the setting out of the road to this bearing. This is done by means of a dial or theodolite. The new road is usually cut in a few yards in the probable direction so as to give room for operations, and the dial is fixed under the point from which the road is to be commenced as shown by fig. 103. The needle of the dial is now allowed to assume its true magnetic position, and when it has settled the dial is turned round until the bearing read off by the needle on the graduated face is exactly similar to the bearing of the proposed road, and the dial is clamped in this position. "Sight lines" are now set out with the dial in the following manner:—The surveyor looks through the narrow slit at the S end of the

dial furthest away from the new road, and with the dial clamped in its original position he directs an assistant, who holds a plumb-bob suspended by a string, to some such point that the string is in the exact line with the vertical hair of the other sight, and a mark is made on the roof at this point. At least two other similar points are determined at a short distance from each other as shown, and by suspending plumb-bobs at these points it can immediately be determined whether a light held at the centre of the face of the workings is exactly in the same line. Thus by frequently taking observations the road may be kept absolutely straight in the required direction. If the roadway is comparatively short, and a definite direction need not be maintained to a high degree of accuracy, the points or positions of the sight lines are marked in chalk and plumb-bobs are placed under these points from time to time; but if greater accuracy is required wooden plugs should be inserted into the roof, and specially prepared spikes should be driven into them. The lower end of the spike is provided with an eyehole for the insertion of the string. If the roof of the mine is soft and

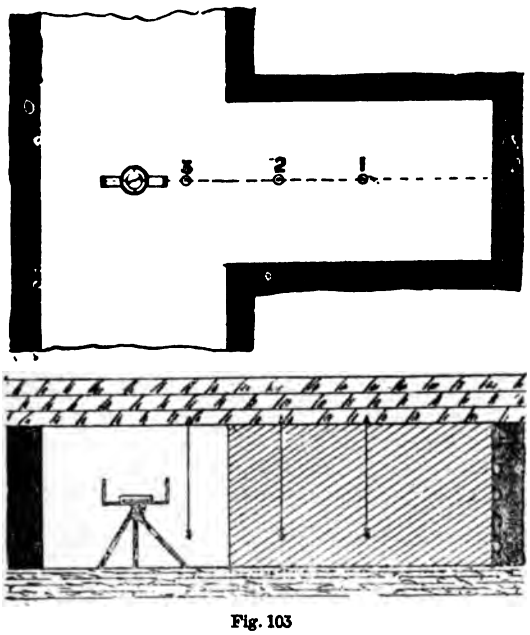


Fig. 103

friable it may become necessary to drive the spikes into the supporting bar timbers, but as these are apt to move from time to time through the pressure of the roof, it is essential that they should be frequently checked.

Theoretically two sight lines are sufficient to sight the road correctly, but there should always be three, so that if one happens to get wrong it can be detected immediately. When fixing the sight lines the first should be placed as far away from the dial as the string can be conveniently seen; the second sight line should be situated midway between the dial and the first, and the third immediately near the dial.

It has been said that if the sight lines are placed near the side of the roadway instead of the centre, the roadway cannot be driven as crooked as it would be possible to do otherwise. This is a fallacy as the roadway can be driven quite as crooked with the lines at the side as at the centre, but there may not be the same attention required to keep it perfectly straight.

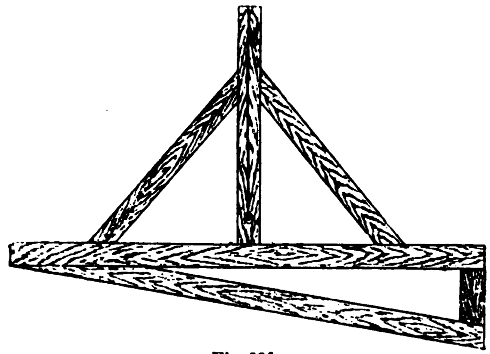


Fig. 104

To keep a tunnel at a given inclination, the instrument shown by fig. 104 is often used. To the centre vertical piece is attached a plumb-bob, and the lower foot-piece is set at the angle or inclination which it is required the tunnel should be driven at. The illustration represents the proper dimensions and angle for an inclination of one in six, the length of the main horizontal piece being 6 feet, and the distance from the bottom of this piece to the bottom of the inclined piece being one foot.

(*Concluded.*)

The articles on the above subject have appeared in all numbers since No. 2, Vol. II., with the exception of the following Nos. 6, 8, 10, 11, 23, and 25, Vol. II.

All back numbers may be had at the office of this paper.

For prices of Bound Volumes see first page of cover.

VENTILATION.

By JOSEPH CARTER, First Class Certificated Manager.

THE advantages of splitting the air in mine ventilation are something more than a greater quantity of air being obtained by the pressure or power used, for we obtain a much greater safety in the mine from various causes, because each district can have its own supply of fresh air independently of the others.

Although by splitting the air we obtain a greater amount of air than by taking the whole of the air through the mine in one undivided current, when we take into consideration the resistances offered by the shafts (which is no small matter, but becomes a great factor in all cases as the examples given below will show), we find that it will not be in the same proportionate increase as in the cases given when shaft resistances were ignored.

The examples I will show are taken from Atkinson's book, where he gives the quantities that would pass in each split, providing the same amount of pressure were used and the same amount of power, and that the resistances of the shaft are equal to one-half of the resistances of the mine when there are five equal splits, which is taken to be not an unusual thing.

The increased quantity of air obtained by splitting depends greatly upon the relative depths and areas of the shafts, as compared with the lengths and areas of the workings of the mine.

The following examples will show the resistances offered by the shafts and airways in each case :—

Here I will say that the areas of the shafts = 80, rubbing surface = 10000 square feet, and the area of the airways when there are five splits = 80, and rubbing surface = 20000 square feet. Under these conditions we shall have the resistances of the shafts half those of the mine when there are five equal splits as desired. In this case, if before splitting we had a ventilation of 10000 cubic feet of air per minute, the following are the quantities given by Atkinson that would circulate by increasing the number of splits, so long as the extent of the workings, shafts, and the ventilating pressure all remained the same :—

No. of Currents.	Quantities of air on the whole.	Quantities in each split.
1	10000	10000
2	27892	13946
3	49449	16480
4	71527	17882
5	90789	18158
6	107800	17966
10	141710	14171

Now we will work out the pressure in each case and note how the shaft pressure increases as each split is made. *Rule, $P = \frac{K\ S\ V^2}{A}$

1st.—One split—Find pressure for this shaft, $S = 10000$, $A = 80$, $V = \frac{10000}{80} = 155$, $V^2 = \cdot015625$, $Q = 10000$ cubic feet, $P = \frac{\cdot0217 \times 10000 \times \cdot015625}{80} = \cdot04238$ lbs. pressure in the shaft.

Now find presure used in the mine for this one split; we say that the five splits are equal in area to the shaft, therefore the area of one must be 16. Find pressure as before, in this case $S = 20000$, $A = 16$, $V = \frac{10000}{16} = 625$, $V^2 = \cdot390625$, $P = \frac{\cdot0217 \times 20000 \times \cdot390625}{16} = 10\cdot59520$ lbs. per square foot.

2nd.—Two splits—Quantity = 27892 cubic feet of air. S and A are the same in each case for the shaft, but the velocities differ. $V = \frac{27892}{80} = 348$, $V^2 = \cdot121104$, $P = \frac{\cdot0217 \times 10000 \times \cdot121104}{80} = \cdot32849$ lbs, pressure in shaft.

Find pressure in the mine for two splits. S in this case remains the same throughout, but the area and velocity differs. $A = 32$, $Q = 27892$ $V = \frac{27892}{32} = 871$, $V^2 = \cdot758641$ $P = \frac{\cdot0217 \times 20000 \times \cdot758641}{32} = 10\cdot28875$ lbs.

3rd.—Three splits, find pressures. $Q = 49449$, $A = 80$, $V = \frac{49449}{80} = 618$, $V^2 = \cdot381924 \therefore P = \frac{\cdot0217 \times 10000 \times \cdot381924}{80} = 1\cdot03596$ lbs. pressure in shaft.

Find pressure in the mine. $A = 48$, $V = \frac{49449}{48} = 1030$, $V^2 = 1\cdot0609 \therefore P = \frac{\cdot0217 \times 20000 \times 1\cdot0609}{48} = 9\cdot59230$ mine pressure.

4th.—Four splits, find pressures. $Q = 71527$, $A = 80$, $V = \frac{71527}{80} = 894$, $V^2 = \cdot799236$, $\therefore P = \frac{\cdot0217 \times 10000 \times \cdot799236}{80}$ $= 2\cdot16792$ lbs. shaft pressure.

Find pressure in the mine. $A = 64$, $V = \frac{71527}{64} = 1117$, $V^2 = 1\cdot247689$, $\therefore P = \frac{\cdot0217 \times 20000 \times 1\cdot247689}{64} = 8\cdot46089$ lbs. mine pressure.

5th.—Five splits, find pressures. $Q = 90789$, $V. = \frac{90789}{80} = 1135$, $V^2 = 1\cdot288225$, $\therefore P = \frac{\cdot0217 \times 10000 \times 1\cdot288225}{80} = 3\cdot49431$ lbs. shaft pressure.

Find pressure in the mine. $A = 80$, the the same as the shaft, consequently velocity will be the same.

$\therefore P = \frac{\cdot0217 \times 20000 \times 1\cdot288225}{80} =$ $6\cdot98862$ lbs. mine pressure.

Notice here the pressure of the shafts is exactly half that of the mine as we stated at first it would be.

6th.—Six splits, find pressures. $Q = 107800$, $V = \frac{107800}{80} = 1347$, $V^2 = 1\cdot814409$, $\therefore P = \frac{\cdot0217 \times 10000 \times 1\cdot814409}{80} = 4\cdot90215$ lbs. shaft pressure.

Find pressure in mine. $A = 96$, $V = \frac{107800}{96} = 1123$, $V^2 = 1\cdot261129$, $\therefore P = \frac{\cdot0217 \times 20000 \times 1\cdot261129}{96} = 5\cdot70145$ lbs. mine pressure.

7th.—Ten splits, find pressure. $Q = 141710$, $V = \frac{141710}{80} = 1771$, $V^2 = 3\cdot136441$ $\therefore P = \frac{\cdot0217 \times 10000 \times 3\cdot136441}{80} = 8\cdot50759$ lbs. shaft pressure.

Find pressure in mine. $A = 160$, $V = \frac{141710}{160} = 885$, $V^2 = \cdot783225$, $\therefore P = \frac{\cdot0217 \times 20000 \times \cdot783225}{160} = 2\cdot12449$ lbs. mine pressure.

		S	A	P	Q
1	Shaft	10000	80	·04238	10000
	Mine	20000	16	10·59520	„
				10·63758	
2	Shaft	10000	80	·32849	27892
	Mine	20000	32	10·28875	„
				10·61724	
3	Shaft	10000	80	1·03596	49449
	Mine	20000	48	9·59230	„
				10·62826	
4	Shaft	10000	80	2·16792	71527
	Mine	20000	64	8·46089	„
				10·62881	
5	Shaft	10000	80	3·49431	90789
	Mine	20000	80	6·98862	„
				10·48293	
6	Shaft	10000	80	4·90215	107800
	Mine	20000	96	5·70145	„
				10·60360	
10	Shaft	10000	80	8·50759	141710
	Mine	20000	160	2·12449	„
				10·63208	

In working out the above—had Atkinson's figures been quite correct—the total pressures in each case would have been the same, however the differences are only slight, and no doubt would have shown less had I taken account of the decimal points in the velocities.

* **EXPLANATION TO ABOVE RULES.**

Q = Quantity A = Area
P = Pressure V = Velocity
V^2 = Velocity squared in thousands of feet per minute
S = Rubbing surface
·02172 K = Co-efficient of friction.

(*To be continued.*)

For particulars of Gold Medal and other Competitions see No. 23, Vol. II., to No. 1, Vol. III.

Literary communications to be addressed to the Editor, "Mining," Clarence Yard, Wallgate, Wigan.

FATAL ACCIDENTS IN MINES.

THE following are the published summaries of Accidents in Mines under the C.M.R.A. for the years 1893-94, the former being given to afford means of comparison for the two years.

Table showing the nature of the accidents and number of deaths caused by each:—

Cause.	No. of Deaths. 1893.	No. of Deaths. 1894.	Total 1893	Total 1894
Explosions of Firedamp.	160	317		
			160	317
Falls in Mines.				
Falls of sides	98	109		
Falls of roof	314	335		
			412	444
In Shafts.				
Overwinding	0	1		
Ropes and chains breaking	6	2		
Whilst ascending or descending by machinery	28	13		
Falling into shaft from surface	6	3		
Things falling from surface	5	4		
Falling from part way down	18	22		
Things falling from part way down	15	2		
Miscellaneous	25	30		
			103	77
Underground.				
By explosives	15	12		
Suffocation from natural gas	14	4		
Falling into water	1	0		
On inclined and engine planes	61	57		
By trams and tubs	70	59		
By machinery	4	9		
Ropes and chains breaking	0	6		
Sundries underground	100	30		
			265	177
On Surface.				
By machinery	16	14		
Boilers bursting	0	0		
Railways and tramways	61	67		
Miscellaneous	43	31		
			120	112
Total in and about Mines			1060	1127

Table showing the number of Separate Accidents and the number of Deaths caused by them for each District for year 1894:—

District.	No. of Sep. Accidents.	No. of Deaths.
Northumberland, Cumberland, and N. Durham	77	78
S. Durham, Westmoreland, and N. Riding, Yorkshire	76	77
Cleveland (ironstone)	12	12
Yorkshire	96	99
Yorkshire (ironstone)	0	0
Lincolnshire ,,	1	1
N. and E. Lancashire	50	51
Ireland	0	0
W. Lancashire and N. Wales	70	72
Derby, Nottingham, Leicester, and Warwick	52	52
N. Staffordshire, Cheshire, and Shropshire	26	27
S. Staffordshire and Worcestershire	47	50
Monmouth, Gloucester, Somerset Devon, Dorset, and parts of Brecon and Glamorgan	48	49
S. Wales	146	440
E. Scotland	63	70
W. Scotland	45	45
W. Scotland (ironstone)	4	4
Totals	813	1127

Table showing in what Hour after the commencement of the shifts the Fatal Accidents occurred in 1894:—

Hour.	No. of Accidents. Underground.	No. of Accidents. On Surface.
1st	75	13
2nd	93	7
3rd	90	6
4th	65	11
5th	99	11
6th	76	14
7th	64	14
8th	57	17
9th	44	8
10th	22	7
11th	10	1
12th	2	1
More than 12	3	2

In mines classed under the Metalliferous Mines Acts there were 30 Accidents causing 46 Deaths in 1894, against 30 Accidents causing 65 Deaths in 1893.

INSPECTION OF MINES.

(COMMUNICATED.)

THE following note which has been taken from a speech made by the Home Secretary (Mr. Asquith) last week, at Bishop Auckland, Durham, may be of interest to our readers:—"When he entered office, 2½ years ago, one of the first facts forcibly brought under his notice was the large amount of what he believed to be preventible loss of life from injury to health sustained every day in the year by workers both in factories and mines. That was one of the most serious facts that they had to confront, one of the great blots upon the industrial system of this country. It was very difficult to deal with the matter either by legislation or administration. He was proud to say that there was a far higher standard of reasonableness of humanity among employers of labour than was the case a generation ago. There was, also, as the result partly of education, of increased sobriety, a stronger sense of family ties and of manly independence on the part of the workers, and a far higher standard of caution and care. But experience showed, the evidence and statistics proved, that, even now, much life was lost, and much health sacrificed from causes which might be got rid of. And it was not sufficient to rely upon individual initiative and energy to deal with a problem such as this. The first and most obvious means of dealing with it was to increase both the scope and efficiency of that system of inspection which the State had devised to see the requirements of the existing law were duly and vigilantly observed. He thought the inspectorate, both of factories and mines, insufficient in numbers for the duties, and in the case of factories and workshops had increased it very largely; whilst in the case of mines, particularly metalliferous mines, he was increasing it slowly, but, he trusted, with some result. In one respect the system of inspection was found to be lamentably deficient; but the defect had been at any rate to some extent removed. Further, and in the same direction, they hoped to bring in and carry a Bill in relation to coal mines, in South Wales in particular, where the loss of life in mining operations vastly exceeded in numbers and relative proportions that which was to be found in any other part of the country. In South Wales, explosions in mines due to coal dust were a fruitful source of disaster. The Government were going to try to devise means—and he hoped they had done so—which, for the future, would make this particular cause of mining accident, he would not say impossible, but, at any rate, of very rare occurrence. They trusted at the same time, and in the same measure, to introduce a number of miscellaneous provisions for strengthening the existing law, and for securing for the miner as far as it was possible for human foresight and legislation to do so, to secure for him something like security from the terrible risks connected with his calling.

EDITORIAL NOTES.

COAL RAISING EXTRAORDINARY.

Mr. G. J. Findlay, A.M.I.C.E., in some correspondence to the *Colliery Guardian*, states—"On several days of late, 1,298 tons of coal have been raised in one pit with two cages in one shift of 8½ hours, at Plas Power Colliery, in Wrexham. Six tubs are raised at one time on three decks. The hitching, banking, and winding is done in 50 seconds. The average weight of each tub is about 9 cwt. Depth of pit 280 yards. The regular time of winding is from 22 to 24 seconds. The above is the ordinary day's winding at this colliery."

COLLIERY EXPLOSIONS.

PROBABLE COAL DUST EXPLOSION IN SOMERSETSHIRE.

An explosion occurred at the Timsbury Colliery near Radstock, on Wednesday, February 6th, late in the night, causing the death of seven miners and wrecking a portion of the workings, There were nine men down the mine at the time of the explosion, and it is stated by the survivors that a miner named Carter, fired a shot in the main road with a view of widening the same, and by so doing caused an explosion in all probability of coal dust.

ANSWERS TO CORRESPONDENTS.

RECEIVED.—A Learner, A. Hart, Miner, G. Daykin, Howker, A Faithful Reader. Will insert these next issue.

MINING PROMOTER.—Are sorry to disappoint you in not answering your query. Will see to it next issue.

J. D. (S. Wales).—The essay you send is not suitable, we did not think it necessary to state more emphatically than we have done that the essays must deal with mining or its allied subjects. We will hewever give you the benefit of the mistake, and will accept another in its stead.

J. McL. (N.B.) — Our correspondent, "J. McL." draws our attention to the fact that our new scheme of Plan Ventilation has been partly copied by others. It is not the first time that our ideas or even literary matter has been appropriated, but we deem it a compliment the more gratifying, as it is an unacknowledged one.

REYNARD.—Mr. Carter informs us he will endeavour to comply with your request, and work out in detail the calculations in his articles for the benefit of those who are deficient in mathematics.

ANSWERS TO QUESTIONS

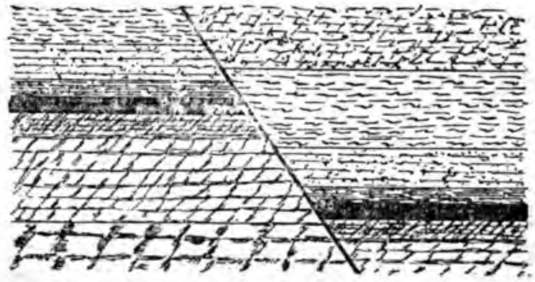
No. 7 Set—In No. 4, Vol. III.

ELEMENTARY.

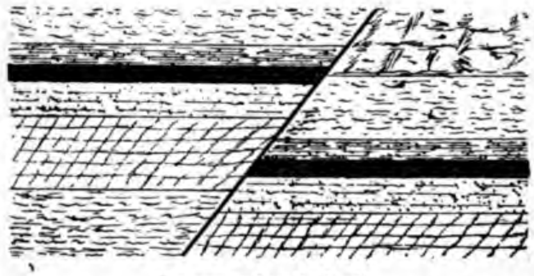
FAULTS.

Question 1.—What are faults? What different kinds of faults are there, how is the direction of the throw usually arrived at, and what indications does the seam in proximity to a fault give? What is meant by the hade of the fault, and what is the usual angle of the hade?

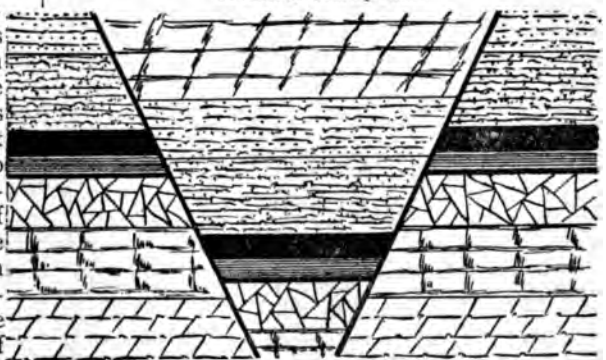
Answer.—Faults are frequently encountered in the working of a coal seam. A fault is a crack or fissure (usually approaching the vertical), on one side of which the beds of rocks have been either elevated or depressed so that they are no longer continuous with the same beds on the other side of the fissure. Originally the beds were deposited in a continuous horizontal line, but owing to various movements in the earth's crust in former periods they have been fractured and we find them lying at different levels. It is not uncommon in working a coal seam to find it suddenly terminate and stone appear in its place accompanied with indications of a fissure filled with a solid mass of broken stone extending upwards and downwards. This is a fault, and the continuation of the coal seam will be found at a different level either above or below. The width of such a fracture varies from a fraction of an inch to several feet. It is usually filled up completely from side to side of the fault, the in-filling material frequently consisting of the broken pieces of rocks through which the fault passes. The amount of vertical displacement varies from an inch to thousands of feet. When the displacement is not more than a few feet the fault is known to miners by the terms of hitch, heave, and slip, but when the amount may be stated in fathoms it is termed a trouble. The amount of the displacement is called the throw, and is the perpendicular distance from the thill or floor of a bed or of a coal seam on the elevated or rise side of the fault to the thill of the same bed or coal seam on the depressed or dip side of the fault. A fault is termed a downcast, downthrow, and dipper, or an upcast, upthrow, and riser, according to the side from which it is approached. For example, if a drift is being driven in a coal seam in a south-east direction and a fault is met with which displaces and throws the seam a depth of 20 feet below the drift, the fault would be termed a dipper or downthrow, south-east of 20 feet, and (*vice-versa*) if the drift had approached the same fault on the downthrow side in a north-west direction it would be a riser or upthrow, north-west of 20 feet.



Normal or Ordinary Fault



Reverse or Overlap Fault



Normal Trough Fault

The different kinds of faults are as follows: The ordinary, overlap or reversed, vertical, trough, reversed trough. The direction of the throw as ascertained by miners is, that the fault hades or slopes in the direction of the downthrow side, that is, the fault leans towards the observer at the top and from him at the bottom when it is a downthrow. In other words, if the angle made between the thill of a coal seam and the fault is an acute angle, the fault will be a dipper. On the contrary, if a fault leans towards the observer at the bottom and from him at the top, or forms an acute angle with the roof of the coal seam, the fault will be a riser. These rules only refer to the direction and not to

the amount of the throw of the beds. The cheeks, sides, or walls of faults are often grooved, smoothed, and glazed, as though they had been rubbed roughly against each other. This appearance is termed *slickenside*. The same kind of thing is often seen in joints and jacks near large faults. The coal adjacent to faults on both sides is in nearly every case more or less altered in thickness, quality, and dip. Sometimes the seam is increased in thickness, but generally the opposite occurs. The coal is also deteriorated, so much so, in some instances, as to be unsaleable; this is usually termed hitch coal. In some cases the coal is rendered very much harder, in other cases softer, than the normal, and occasionally no change of any kind occurs in working a seam near a fault until the fault is reached. More frequently changes are noted particularly of the dip.

Hade is applied to the inclination of the fault from the perpendicular, and the term, dip, is applied to the inclination of strata with the plane of the horizon. Hade is measured by the angle which a fault makes with the perpendicular plane; dip is measured by the angle which a bed makes with the horizontal plane. The hade of a fault is of great value in mining in assisting to determine whether the throw of the beds is upwards or downwards, or in other words, if the fault is a dipper or riser. The usual angle of the hade is from 20 to 60 degrees, which allows of a large margin. J. H. HUTCHINSON.

ADVANCED.

SHAFT SINKING THROUGH QUICKSAND.

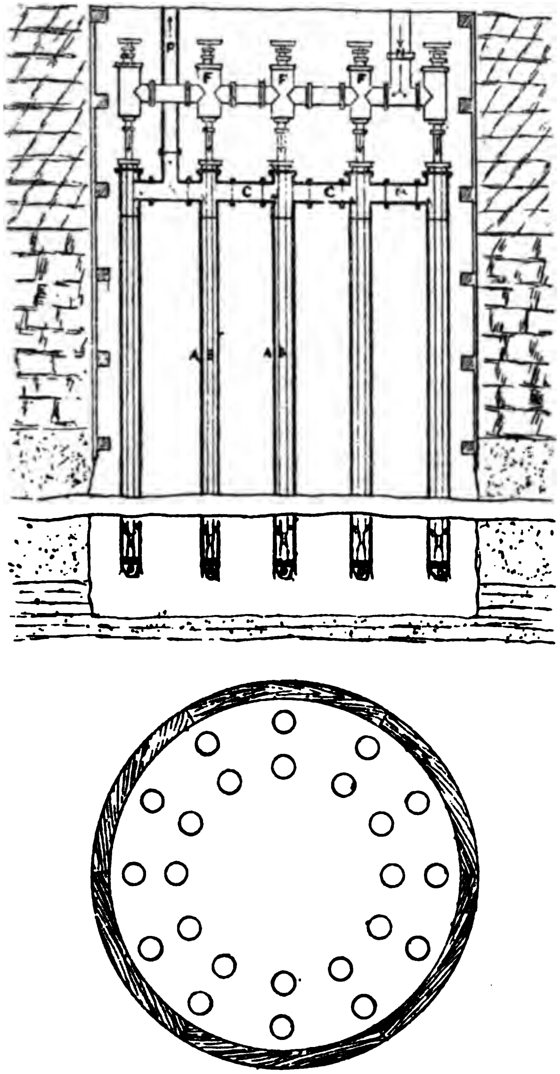
Question 2.—How is the sinking of a shaft conducted through quicksand? Give sketches.

Answer.—There are several methods of sinking through quicksand, viz.:—Poetsch's method of freezing, sand tubbing, piling, etc., and each are applicable to special circumstances.

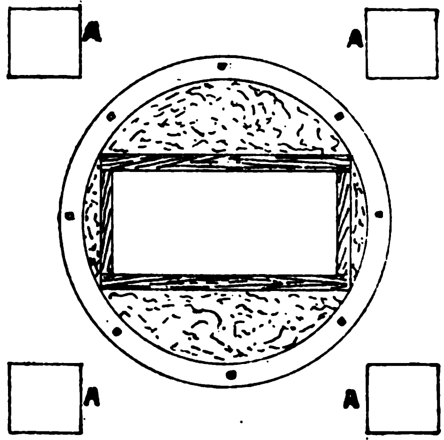
Poetsch's system is employed to go through sand-beds when met with at some depth. There are seven stages in the process, viz.:—(1) Putting 8″ pipes through the quicksand. (2) Emptying the same. (3) Closing the ends with lead and pitch. (4) Putting 3″ pipes inside of the larger ones, connecting all large pipes together and all smaller ones. (5) Forcing a cooling liquid (chloride of calcium at —34° C.) down through small tubes from a refrigerator and up through the large pipes until the sand is frozen, which may take weeks or months. (6) Cutting out frozen blocks and removing same until some hard strata is reached, (7) Building up brick walling or metal tubbing to hard strata above. I would not adopt this method if it could be managed without, as it is very expensive, costing from £20 to £40 per foot of sinking. The sketches will fully explain this method.

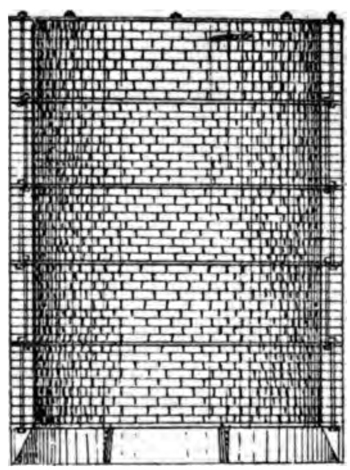
The general method employed in sinking through quicksand at the surface is by piling. Take a case of sinking through, say 40 feet of quicksand, I would use four sets of piles, 13′ × 6″ × 3″, bevelled on one side only, shod with iron at the point, with iron hoop on the top, the bevelled side to be kept to the inside when being driven, and cribs (made of oak or elm) 6″ square, put in every 3 feet, also stringing deals upon face of cribs, and possibly there might be required a punch prop here and there. As each set of piles requires 1′ 6″ and four sets are used, then 4′ × 1′ 6″ = 6 feet, walling or tubbing, say 9″ work, this would be another 1′ 6″ ∴ 6′ × 1′ 6″ = 7′ 6″. If the shaft had to be 14′ when finished, it would have to be 14′ × 7′ 6″ = 21′ 6″ at the commencement.

Another method which I saw successfully applied a few years ago, in Slamannan district, is as follows:—A large cast-iron crib was brought in segments to the place where the pit was to be sunk and bolted together. There were a number of holes around the centre of this crib and 1¼″ bolts, 4′ 6″ long, put in them. The bricklayers now built 4′ 6″ of brickwork on the top of this crib and a maleable iron ring, 4″ × ½″, was placed upon these bolts and screwed down tight, leaving a number of bolts sticking up through this ring so as to bolt the next 4′ 6″ of brickwork. By building on the top and digging out the centre the hard strata was reached (17 feet) very successfully. Four powerful jib cranes situated at A A were attached to four of the bolts which were sticking up for the next set of brickwork by means of strong eye-bolts—the nuts being taken out of the bolts and the eye-bolts screwed on in their place. The surface was planked and cross-planked for the cranes to rest upon with pitch-pine planks 20′ × 12″ × 4½″ to prevent them from sinking in the soft surface. If one side of the shaft showed signs of going down quicker than the other the cranes on that side were tightened and those on the opposite side slackened, thus sinking the shaft perfectly straight. The shaft was sunk rectangular after the hard strata was reached, and the wood tubbing carried right to the surface; behind the tub-



Poetch's Freezing System of Sinking.

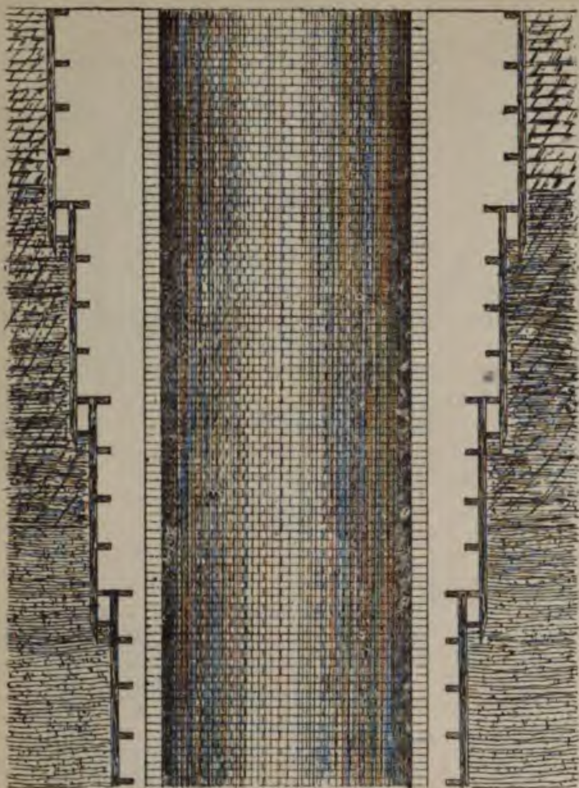




Sinking with Brick Cylinders.

bing was packed with clay. For sinking through soft watery moss, sand, or mud, I think this method would answer the purpose, as it is often asked at a C.M. Exam. how would you sink through so many feet of moss, etc., and how would you remove it? I believe brick cylinders could be forced through it so close together that iron or steel girders could be laid upon them to support the whole colliery plant.

Sand tubbing is successfully used when the sand is very quick running or watery. A case of this kind occurred about 14 years ago in Ayrshire. After proving the field by boring they began to sink, but as the nearest bore to the railway was about 1½ miles off they decided to sink the pit at the railway side and save the expense of making a branch line. When the shaft had been sunk about 50 fathoms they came across a bed of running sand unexpectedly. They then ascended the shaft about two fathoms and commenced to widen it out about 9 ins., which was 1′ 6″ wider than the finished size. They also cut the metals square so as to be level for the heads of the hydraulic jacks and screws. Being a rectangular shaft they got a C.I. tank, without a bottom or top, fitted together in plates, to suit the size of the shaft, 20′ × 7′ 6″, which they took down and set round the shaft and then bolted them together; the hydraulic jacks and



Pile Driving

screws were also set all round. With the top of the hydraulics against the hard strata above they forced the plates down, putting another set of plates on the top of these they again forced them down, digging out the centre. This operation was carried on until the running sand was got through, when it was wooded up the face of the metal tubbing and the whole process successfully accomplished. To say definitely how any such bed ought to be sunk I certainly should be guided by the particular case in hand, because what would do in one case might not do in another. The depth of the bed and the nature of it, and the depth from the surface and the metals above it, all these would require consideration.

THOS. E. AITCHISON.

FIRST-CLASS.

LAYING OUT A COAL SEAM.

Question 3.—A coalfield of 500 acres has been fitted, and it is desirable to have a large output from the only workable seam, 220 yards deep, as soon as possible. The coal is 6 feet thick and is only suitable for working stoop and room. The dip is 1 in 8. Sketch and describe how you would lay out the workings in such a manner that within 18 months you would have three sets of colliers at work, viz. :—

(*a*) Winning out levels and headings and forming large blocks or areas of coal.
(*b*) Splitting such blocks into 16 or 18 yard pillars.
(*c*) Taking out the 16 or 18 yard pillars.

The seam is fiery and particular attention will be required to lay out the airways so that the stoopers (who only work with safety lamps) shall have the air from the other sections, and that no others use it after airing the pillar workings. Show the course of the ventilation and the accessories for same.

Answer.—The shafts will no doubt have been sunk as near the lowest point as possible with regard to local conditions, hence there will not be much coal to the dip. The annexed sketch illustrates a district to the rise. There will be another district on the opposite side of the shaft, similar to the one given in sketch, also other districts will be in course of extension. The headings and main places will be kept working night and day, so as to procure a large output by the end of 18 months. The headings will advance about 40 or 50 yards per fortnight if circumstances are favourable. The whole will be followed by the splitting, and the splitting of the pillars will be followed by the broken or the taking out of the split pillars. Thus the rails or plates laid down for the whole working will not be removed until all the coal has been removed. The sketch shows the operations of these three methods. The ventilation of the workings is shown on the plan, the air is first taken direct to the whole workings and then it is directed to the broken workings.

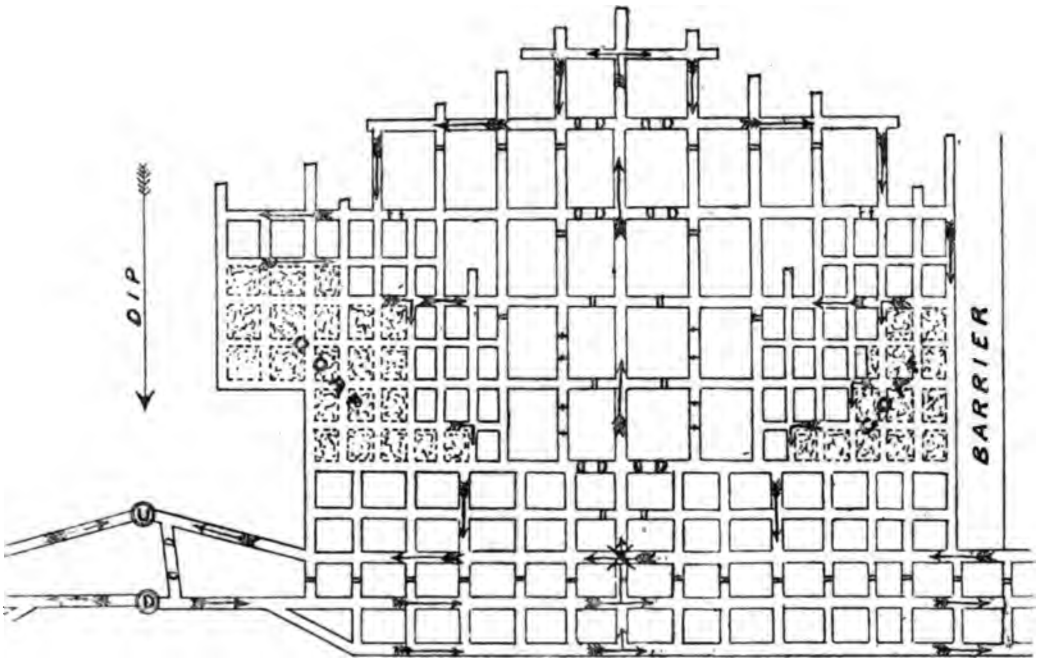
MYLES BROWN.

See illustration on page 91.

ANNOUNCEMENT TO OUR READERS.

Re Mine Ventilation Made Easy.

We regret to state that the Articles on Ventilation, by W. Fairley, will not be continued in our paper. We do not doubt that we have right to publish them, but the question could only be decided at a considerable cost and we prefer acquiescing to the request of Hutching's Publishing House rather than go to further trouble.



Sketch illustrating Question 3.

REFERENCES.

U Upcast
D Downcart
DD Doors
X Air-crossing
|| Brick Stopping
†† Cloth Sheets
Direction of current shown by arrows

AWARDS

FOR ANSWERS TO COMPETITION QUESTIONS.—No. 7 SET.

ELEMENTARY.—J. H. Hutchinson, No. 1, Carlton Road, Smithies, Barnsley.

Commended.—T. Webster, J. Stephenson, J. H. Senior, B. Turner, J. Wheatcroft, R. Cherry,

ADVANCED.—T. E. Aitchison, Green Hill, Dunaskin, Ayrshire.

Commended.—G. Bell, E. J. Hindley, H. Talbot, C. Carter, J. P. Donohue, M. Mourley, W. Sutherland, J. Craggs, D. Hall, J. Crone,

FIRST-CLASS.—Myles Brown, Butterknowle, Darlington.

Commended.—J. Davies, J. Mann W. Slocombe, J. McPhail, Geo. Daykin,

COMPETITION QUESTIONS

No. 10 SET.

TO the sender of the best set of Original Answers in each Stage will be awarded the following:—

Elementary 2s. 6d., Advanced 3s. 6d., First-Class 4s. 6d.

A Competitor may only answer one Stage in each issue, though a different Stage may be taken in another issue. The best answer to each question will be published with the sender's name and address.

1.—All envelopes must be marked "COMPETITION."

2.—To be written on separate sheets of paper with name attached, and on one side of the paper only. Sketches to be in ink on *unruled* paper.

3.—Correct name and postal address must be sent.

4.—They must reach us by March 8th, 1895.

5.—The Editor's decision as to winners to be final.

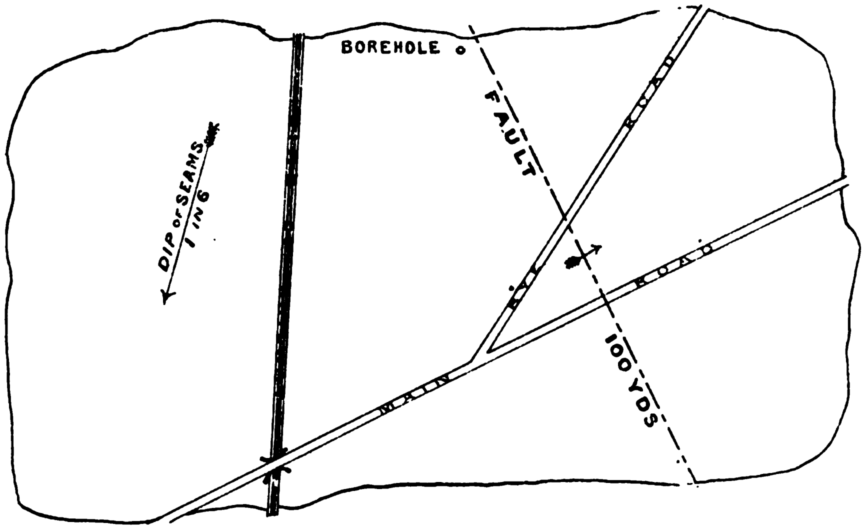
ELEMENTARY.

Question 1.—Describe with suitable sketches the primitive methods of ventilating mines.

Surface Plan
OF
PROPOSED COLLIERY

NOTE—
DEPTHS OF MINES AT BOREHOLE.

6-ft. Mine	(suitable for stoop & room)		50	Yards
4-ft.	„	„ longwall	100	„
3-ft.	„	„ „	180	„
5-ft.	„	„ „	220	„



SCALE—400 YARDS TO AN INCH.

ADVANCED.

Question 2.—Describe the usual arrangement for bringing coal from the working face to the wagon road in mines of considerable dip, and say what contrivances and precautions should be adopted to ensure the safety of the workmen.

FIRST-CLASS.

Question 3.—The above plan shows an estate from under which it is proposed to work the four mines found at the borehole. The mines on both sides of the fault must be got and workings must commence in all the four seams before 15 years. A large output is desired as soon as possible. You are required to give the following information:—

(1) What capital would be necessary to fully equip the colliery before any reinbursement could be expected, and give the principal details of costs.

(2) Best position, number, and depths of shafts. (For calculations the surface may be assumed as level and the strata to give off an ordinary quantity of water).

(3) Show how you would ay out the workings in the 6ft. mine and in one of the others.

(4) Show how you would win the seams on the other side of the fault to whcih the shafts are situated.

(5) Give the order in which the seams should be worked.

(6) How long would it take to obtain the maximum output and how many tons would be won daily? Give any other particulars or sketches you may deem necessary.

N.B.—The above question affords ample scope for a student to exercise his energies, and gives every opportunity for the display of his ability.—Ed.

VENTILATION PLANS.

Students' Method of Ventilating Criticised.

We will criticise a student's attempt at ventilating any of the plans which have appeared in Nos. 3 and 6, Vol. III., and return him plan correctly ventilated at a charge of 9d. each.

Any of the plans may be had shewing the ventilation at a charge of 3d. each.

Correspondence unavoidably held over until next issue.

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MINING

A JOURNAL DEVOTED TO THE INTERESTS OF MINI

o 8. Vol. III. SATURDAY, MARCH 9, 1895. FORTNIGHTLY. ONE PENNY.

CONTENTS.

COAL MINING IN INDIA.

MR. J. GRUNDY, H.M.I.M., has, in the report which he was commissioned to make of the mines of India, given us a very fair idea of what mining must have been in its earlier stages in our own country. The advanced nature of mining methods and practices with which we have become familiar of later years, makes it almost incredible that a country which has been within easy reach of Europeans for so many years should show such utter lack of the most rudimentary mining principles in these enlightened times, and this in a country under British control, and pervaded throughout by large numbers of our countrymen. Mr. Grundy has inspected sixty-seven separate mines for the purpose of making his report, thirty-two of the mines being owned by Europeans and thirty-five by natives. To abbreviate Mr. Grundy's report somewhat, we may say the mines inspected are of considerable thickness, ranging from about 6 feet to even in one case 100 feet, but no attempt seems to have been made to connect the seams of one district with that of another, so that no correct idea can as yet be formed as to the geological structure generally. The dip of the seams is 1 in $3\frac{1}{2}$ at the greatest, but varies considerable between this and the horizontal. The officials in general are incompetent for the work, and especially so in native mines, some of them have had very little experience in mining, and know nothing of the essential principles and practice of mine ventilation, timbering, &c. Mr. Grundy proposes that every mine employing 100 persons underground during any 24 hours should be under the control of a first-class certificated manager, and those mines employing less than 100 men underground by a first or second-class certificated manager. That there should be first and second-class certificates of competency to be gained by examination, and that certificates under the English Mines Act should be recognised. He also proposes that certificates of service should be granted to those who have been officials for a number of years. The system of working adopted is the pillar and stall, the galleries being about 10 to 12 feet wide, and there seems to be a tendency of forming larger pillars than has prevailed hitherto. At seven collieries the pillars have been won, but in the others the work simply consists of cutting out. The ventilation of the collieries visited is in a very deplorable condition, only six used air doors, three used bratticing, nine had some stoppings built, and one had an air crossing. Only four had a furnace or apparatus used especially for ventilation. In the majority of cases the roads are driven indiscriminately without any thought being given to the ventilation. Firedamp is not regularly tested for in the Bengal mines, and when it is found it is generally by its having made itself known in its own rough way. There seems to be no doubt that accumulations of firedamp exist frequently, but the foul stagnant air has perhaps prevented many explosions. Of the mines visited only thirty-six had plans kept of the underground workings, and a number

of these especially in the native mines are of questionable accuracy. Most mines have at least two pits and two inclines, or one pit and one incline; but a few have no second pit or outlet, and the machinery is not good, the ventilation stagnant, the galleries were full of smoke and appeared to be unfit to live in. The minerals are brought out in many cases by boys, girls, women and men, who carry baskets, holding about 100 lbs. each on their heads, and walk or climb up the inclines. The coal is also carried in a similar manner long distances underground, trams and tram lines being little used. At a few mines there are self-acting planes, and also steam engine haulage, and ponies were used in three mines. The coal is also brought to the surface by steam engines, with wire ropes hauling gangs along the inclines, winding trams in cages, and winding up large buckets. Coal is also wound by gins which are worked by females, twenty to twenty-eight being employed, five or seven at each of the four arms. Another way that is mostly practised at sinking pits is to have the smallest possible amount of headgear, namely, two upright or slanting poles sunk into the ground with a cross-piece near the top, a pulley from 8 to 12 inches in diameter, fastened to the cross-piece by a rope or chain, a small basket or bucket, and a hemp or wire rope at which from twenty to nearly forty females pull as they walk merrily over the ground a distance equal to the depth of the pit. Mr. Grundy does not advise the prohibition of female labour underground as the work appears to be natural to them, and not as was the case in this country. The females usually work with their relations, and the prohibition of female labour underground would cause considerable distress and dissatisfaction as there is no other work for them to do.

SPECIFIC GRAVITY OF SOLIDS.

Sp. G. of Water = 1.

Iron Ore	5·2	Clay	1·91
Granite	2·95	Sand	1·90
Mica	2·85	Phosphorous	1·77
Limestone	2·84	Coal	1·30
Slate	2·83	Resin	1·20
Marble	2·73	Amber	1·09
Quartz	2·65	Human Body	1·07
Flint	2·59	Camphor	·99
Chalk	2·55	Whalebone	·94
Rock Salt	2·22	Gunpowder	·94
Graphite or Plumbago	2·16	Ice	·92
Sulphur	2·00	Tallow	·92
Coke	1·95	Animal Charcoal	·80

VENTILATION.

By JOSEPH CARTER, First-Class Certificated Manager.

IF the same power was used as in the last example, then the quantities would be considerably less after splitting than if the pressure remained equal. To show this I will take the same example:—

Area of shaft = 80 feet, rubbing surface = 10000 square feet, and the area of the airways when there are five equal splits=80 feet, and rubbing surface = 20000 square feet. Under these conditions, as before, we have shaft resistances equal to half those of the mine when there are five equal splits

If as before we had 10000 cubic feet of air before splitting the quantities given by Atkinson, when the power remains unaltered, are as follows:—

No. of Currents.	Quantities of air on the whole.	Quantities in each split.
1	10000	10000
2	19813	9906
3	29022	9674
4	37121	9280
5	43736	8747
6	48797	8133
10	58556	5856

We will now work out the pressure in each and find units of work in each split for each case. Notice the increase of power in shaft as K = ·0217 co-efficient of friction, A = area, S = rubbing surface, V = velocity, V^2 = velocity in thousands of feet per minute. Obtained thus:—

$V^2 = \left(\frac{V}{1000}\right)^2$ P=pressure, U=units of work, Q = quantity of air, U = P Q.

The pressure multiplied by the quantity:—

Rule, $P = \frac{K S V^2}{A}$ $\quad U = \frac{K S V^2 Q}{A} = Q P$

1st.—One split—Find shaft pressure and units of work expended. S = 10000, A = 80,

$$V = \frac{10000}{80} = 125 \quad V^2 = \left(\frac{125}{1000}\right)^2 = \cdot015625$$

$$P = \frac{\cdot0217 \times 10000 \times \cdot015625}{80} = \cdot04238 \text{ lbs.}$$

$$\times\ 10000 = 423\cdot8 \text{ units of work.}$$

Find pressure used in the mine for this one split. If five splits are equal to the area of the shaft, the area of one split must be 16,

because $\frac{80}{5} = 16 \quad S = 20000$

Find pressure and units of work as before.

$$P = \frac{\cdot 0217 \times 20000 \times \cdot 390625}{16} = 10\cdot 59520 \text{ lbs.}$$

$\times\ 10000 = 105952$ units of work.

2nd. — Two splits — Quantity $= 19813$

$$V = \frac{19813}{80} = 247 \quad V^2 = \left(\frac{247}{1000}\right)^2 = \cdot 061009$$

S and A in the shaft remain the same in every case, but the velocities differ.

$$P = \frac{\cdot 0217 \times 10000 \times \cdot 061009}{80} = \cdot 16548 \text{ lbs.}$$

$\times\ 19813 = 3278\cdot 65524$ units of work.

Find pressure and units of work in the mine for two splits. S in this case remains the same throughout, but the area and velocity differs. $A = 32$, $Q = 19813$,

$$V = \frac{19813}{32} = 619 \quad V^2 = \left(\frac{619}{1000}\right)^2 = \cdot 383161$$

$$P = \frac{\cdot 0217 \times 20000 \times \cdot 383161}{32} = 5\cdot 19662 \text{ lbs.}$$

$\times\ 19813 = 102961\cdot 63206$ units of work.

3rd.—Three splits—Find pressures and units of work in shaft. $A = 80$, $Q = 29022$,

$$V = \frac{29022}{80} = 362 \quad V^2 = \left(\frac{362}{1000}\right)^2 = \cdot 131044$$

$$P = \frac{\cdot 0217 \times 10000 \times \cdot 131044}{80} = \cdot 35545 \text{ lbs.}$$

$\times\ 29022 = 10315\cdot 86990$ units of work.

Find pressure, &c., in the mine:—

$A = 48 \qquad Q = 29022$

$$V = \frac{29022}{48} = 604 \quad V^2 = \left(\frac{604}{1000}\right)^2 = \cdot 364816$$

$$P = \frac{\cdot 0217 \times 20000 \times \cdot 364816}{48} = 3\cdot 29854 \text{ lbs.}$$

$\times\ 29022 = 95730\cdot 22788$ units of work.

4th. — Four splits — Find pressures and units of work in shaft. $A = 80$, $Q = 37121$,

$$V = \frac{37121}{80} = 464 \quad V^2 = \left(\frac{464}{1000}\right)^2 = \cdot 215296$$

$$P = \frac{\cdot 0217 \times 10000 \times \cdot 215296}{80} = \cdot 58399 \text{ lbs.}$$

$\times\ 37121 = 21678\cdot 29279$ units of work.

Find pressures and units of work in mine.

$A = 64 \qquad Q = 37121$

$$V = \frac{37121}{64} = 580 \quad V^2 = \left(\frac{580}{1000}\right)^2 = \cdot 3364$$

$$P = \frac{\cdot 0217 \times 20000 \times \cdot 3364}{64} = 2\cdot 28123 \text{ lbs.}$$

$\times\ 37121 = 84681\cdot 53883$ units of work.

5th.—Five splits—Find pressure and units of work in the shaft. $A = 80$, $Q = 43736$,

$$V = \frac{43736}{80} = 546 \quad V^2 = \left(\frac{546}{1000}\right)^2 = \cdot 298116$$

$$P = \frac{\cdot 0217 \times 10000 \times \cdot 298116}{80} = \cdot 80863 \text{ lbs.}$$

$\times\ 43736 = 35366\cdot 24168$ units of work.

Find pressure and units of work in mine. A, Q, V, and V^2 are the same as in the shaft in this case.

$$P = \frac{\cdot 0217 \times 20000 \times \cdot 298116}{80} = 1\cdot 61726 \text{ lbs.}$$

$\times\ 43736 = 70732\cdot 48336$ units of work.

Notice here that the units of work, or power expended in the shaft, is half that expended in the mine, as we stated it would be.

6th.—Six splits—Find pressures and units of work in the shaft. $A = 80$, $Q = 48797$,

$$V = \frac{48797}{80} = 609 \quad V^2 = \left(\frac{609}{1000}\right)^2 = \cdot 370881$$

$$P = \frac{\cdot 0217 \times 10000 \times \cdot 370881}{80} = 1\cdot 00601 \text{ lbs.}$$

$\times\ 48797 = 49090\cdot 26997$ units of work.

Find pressure and units of work in mine.

$A = 96 \qquad Q = 48797$

$$V = \frac{48797}{96} = 508 \quad V^2 = \left(\frac{508}{1000}\right)^2 = \cdot 258064$$

$$P = \frac{\cdot 0217 \times 20000 \times \cdot 258064}{96} = 1\cdot 16666 \text{ lbs.}$$

$\times\ 48797 = 56929\cdot 50802$ units of work.

7th.—Ten splits—Find pressure and units of work in the shaft. $A = 80$, $Q = 58556$,

$$V = \frac{58556}{80} = 732 \quad V^2 = \left(\frac{732}{1000}\right)^2 = \cdot 535824$$

$$P = \frac{\cdot 0217 \times 10000 \times \cdot 535824}{80} = 1\cdot 45342 \text{ lbs.}$$

$\times\ 58556 = 85106\cdot 46152$ units of work.

Find pressure and units of work in mine.

$A = 160 \qquad Q = 58556$

$$V = \frac{58556}{160} = 366 \quad V^2 = \left(\frac{366}{1000}\right)^2 = \cdot 133956$$

$$P \quad \frac{\cdot 0217 \times 20000 \times \cdot 133956}{160} = \cdot 36335 \text{ lbs.}$$

$\times\ 58556 = 21276\cdot 32260$ units of work.

		S	A	Q	Pressures P	Units of work U = P Q
1	Shaft	10000	80	10000	·04238	423·8
	Mine	20000	16	,,	10·59520	105952·0
					10·63758	106375·8
2	Shaft	10000	80	19813	·16548	3278·65524
	Mine	20000	32	,,	5·19662	102961·63206
					5·36210	106240·28730
3	Shaft	10000	80	29022	·35545	10315·86990
	Mine	20000	48	,,	3·29854	95730·22788
					3·65399	106046·09778
4	Shaft	10000	80	37121	·58399	21678·29279
	Mine	20000	64	,,	2·28123	84681·53883
					2·86522	106359·83162
5	Shaft	10000	80	43736	·80863	35366·24168
	Mine	20000	80	,,	1·61726	70732·48336
					2·42589	106098·72504
6	Shaft	10000	80	48797	1·00601	49090·26997
	Mine	20000	96	,,	1·16666	56929·50802
					2·17267	106019·77799
10	Shaft	10000	80	58556	1·45342	85106·46152
	Mine	20000	160	,,	·36335	21276·32260
					1·81677	106382·78412

We have now noticed splitting of air under three conditions, viz. :—(1st) Without taking into consideration shaft resistance. (2nd) Taking into account shaft resistance and pressure remaining the same. (3rd) Taking into àccount shaft resistance and power or units of work remaining the same, and notice the different results arrived at thereby. Had the quantities given by Atkinson been quite correct the pressures and units of work would have been the same in each. However, the difference is only slight and I will refer to it later on and work out the quantities according to Fairley's rule.

(*To be continued.*)

As some of our younger students and some who are not so far advanced have written desiring that I should work out some of the examples in detail I will retrace my steps and begin with the principal laws of ventilation, which must be thoroughly understood by all students in order to understand the calculations derived from such. I must say I had no intention of giving a series of articles on ventilation when I referred to this subject in Vol. III, No. 5, or I should have commenced at the beginning, but as the subject is one of great importance in mining I will endeavour to make it as clear as possible to young students and lead them on gradually to the more difficult calculations, and hope by doing so it may give them a greater impetus to proceed in their studies.

Correction in last issue, page 83 :—

1st.—One split. $V = \frac{10000}{80} = 125$ and not 155

The example is worked out from 125, therefore the other portion is correct.

COMPETITION QUESTIONS.

No. 11 SET.

TO the sender of the best set of Original Answers in each Stage will be awarded the following :—

Elementary 2s. 6d., Advanced 3s. 6d., First-Class 4s. 6d.

A Competitor may only answer one Stage. The best answer to each question will be published with the sender's name and address.

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3.—Correct name and postal address must be sent.

4.—They must reach us by March 22nd, 1895.

5.—The Editor's decision as to winners to be final.

ELEMENTARY.

Question 1.—Describe briefly with sketches the primitive methods of winding.

ADVANCED.

Question 2.—Describe two methods of longwall working, suitable for flat and inclined seams respectively. Give sketches.

FIRST-CLASS.

Question 3.—

(*a*) Has coal dust any effect on the flame of a lamp?

(*b*) How is coal dust dangerous in dry mines?

(*c*) Are all coal dusts alike inflammable?

(*d*) What precautions should be taken to minimise the danger?

IMPORTANT NOTICE TO COMPETITORS.

Competitors who have gained a First-Class Elementary in Mining (Science and Art Department) or other Examination are *not* eligible for the Elementary Stage.

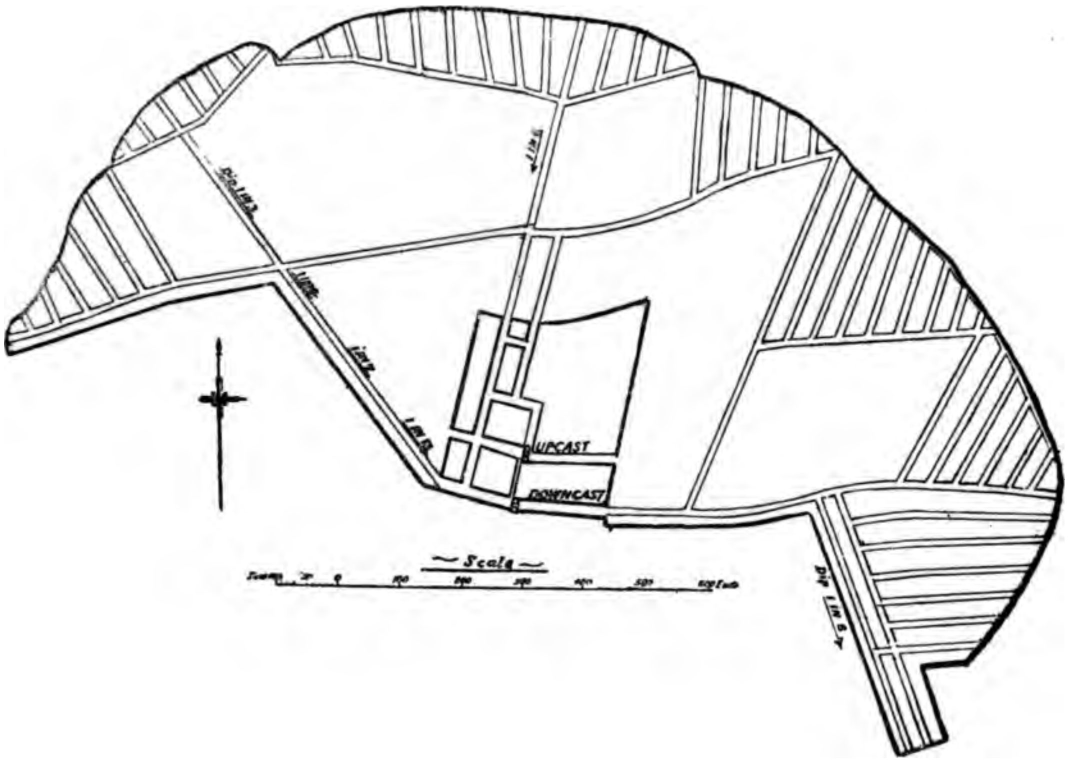
Competitors with First-Class in the Advanced Stage, and those possessing First or Second-Class Certificates of Competency are only eligible for the First-Class Competition.

Those students who are not at present complying with the above will please do so at once.—EDITOR.

VENTILATION PLAN

Given in West of Scotland District Examination for First and Second-class Certificates of Competency.

1891.



For the general benefit of our readers we will publish the above plan showing a method of ventilating same in next issue.

Students Method of Ventilation Criticised.

We will criticise a student's method of ventilating the above plan, explaining its deficiencies and what should be considered in such circumstances at a charge of 6d. each.

The following conditions must be observed:

(*a*) Name and address of the sender to be written upon the plan. The criticisms will be returned the following week.

(*b*) Plans to be sent in before March 16th.

(*c*) Plans to be sent separate, *i.e.*, not enclosed with competition questions. Envelopes to be marked "Plan."

We will also criticise a student's attempt at ventilating either of the plans which have appeared in Nos. 3 and 6, Vol. III., and return him same correctly ventilated at a charge of 9d. each.

Any of the plans may be had shewing the ventilation at a charge of 3d. each.

Considerable delay and inconvenience has been caused by students sending the Plans with the Competition Questions. We hope this will not occur again.—Ed.

EXPLOSIVE EXPERIMENTS

Near Wigan.

STILL another series of experiments were conducted on Friday, the 22nd February, at the experimental station at Messrs. Pearson and Knowles, Ince, with a view to further testing the relative qualities of the explosives at present in the market. The experiments were given on behalf of the Council and Members of the Midland Institute of Mining, Civil, and Mechanical Engineers. In each case half a cubic foot of Arley coal dust was used, except in shot No. 15, where 12 ounces of Westphalite were fired in half a cubic foot of coal dust, together with 9 per cent. of gas. The following are the results:—

Shot.	Explosive.	Weight used.	No. of Detonator.	Result:
1	Ammonite	12oz.	6½	No explosion; no flame.
2	Carbonite	12oz.	6½	No explosion; no flame. no ignition.
3	Roburite	12oz.	6½	No explosion; no flame.
4	Roburite	12oz.	6½	Violent explosion; ignition; and large flame.
5	Bellite	12oz.	6½	Violent explosion; ignition; and large flame.
6	Westph'lite	12oz.	6½	No explosion; no ignition (incomplete test).
7	Westph'lite	12oz.	8	No explosion; no ignition; no flame.
8	Tonite	12oz.	6½	Violent explosion; ignition; large flame.
9	Ammonite	12oz.	6½	Violent explosion; ignition; large flame.
10	Carbonite	12oz.	6½	No explosion; no ignition; no flame.
11	Ardeer Powder	12oz.	6½	No explosion; no ignition; no flame.
12	C'mpr's'd Powder	8oz.	6½	Violent explosion; ignition; large flame.
13	Dynamite	2oz.	6½	No explosion; no ignition.
14	Westph'lite	12oz.	8	No explosion; no ignition; no flame.
15	Westph'lite	12oz.	8	No explosion; no ignition; flame.

N.B.—(1) Immediately before these tests commenced a Bellite shot was fired into coal-dust, which completely ignited it.

(2) Upon several occasions sparks were observed (but no ignition) flying out of the mouth of the testing tube, doubtless from the still smouldering coal-dust which had been completely ignited and set ablaze by a preceding shot.

(3) The coal-dust in shots Nos. 1, 2, and 3 was found to be too damp to remain in suspension, and could not be exploded, having been left exposed to the open air, owing to the fact that the safety tests commenced at 2-30 p.m., instead of 10-30 a.m., therefore these three shots cannot be regarded as satisfactory. All the remaining shots were fired into perfectly dry Arley coal-dust brought direct from the pit.

(4) Dynamite shot No. 13: By mistake only a 2oz. charge was used instead of 8oz.

(5) All shots were placed in the mortar and tried under the severe conditions of unstemmed shots straight into the inflammable mixture by a member of the Midland Institute of Mining, Civil, and Mechanical Engineers.

EDITORIAL NOTES

ON SUBJECTS OF GENERAL INTEREST.

THE C.M.R.A. ON THE USE OF LAMPS AND SHOT-FIRING.

A correspondent wishes us to answer his queries *re* the above, which appeared in No. 2, Vol. III, and we have much pleasure in doing so.

1. A completely closed chamber we understand to mean a chamber which is securely isolated from the atmosphere. A better eaxmple cannot be given than an electric battery.

2. (*a*) It is illegal for a shotsman or examiner to have in his possession lucifer matches (*i.e.* in a mine where locked safety lamps are used), unless it were possible to have them in a closed chamber fulfilling the above conditions and attached to the fuse. (*b*) Yes, a shotsman may have in his possession a contrivance for unlocking a safety lamp. (*c*) A shotsman may fire a shot with a naked light even in a district where locked safety lamps are used, providing the conditions relative to the presence of inflammable gas and coal dust are observed.

3. It is difficult to say what restrictions should be made on the above privileges for the safety of the workmen. Other than none but competent men, who are fully aware of the danger, should be appointed to do the work. This condition is enacted by the C.M.R.A., but under existing arrangements there are no means of telling whether it is being fulfilled or not, indeed, from some assertions made in our correspondence columns a short time ago, it would appear that it would bear further investigation. We advocate as the most practical means of ensuring the fulfilment of the Act that officials, such as shotsmen, should be compelled to pass an examiuation, somewhat similar to that already enforced for managers and under-managers, but of a more elementary character, dealing principally with mine gases and ventilation.

Literary communications to be addressed to the Editor, "Mining," Clarence Yard, Wallgate, Wigan.

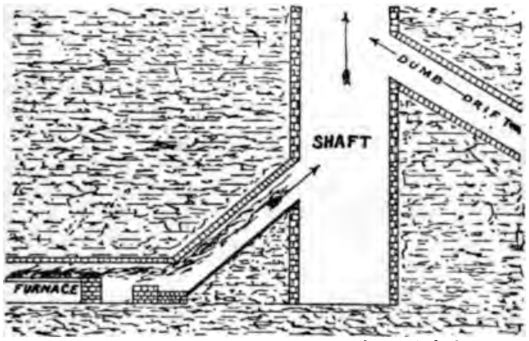
ANSWERS TO QUESTIONS

No. 8 Set—In No. 5, Vol. III.

ELEMENTARY.

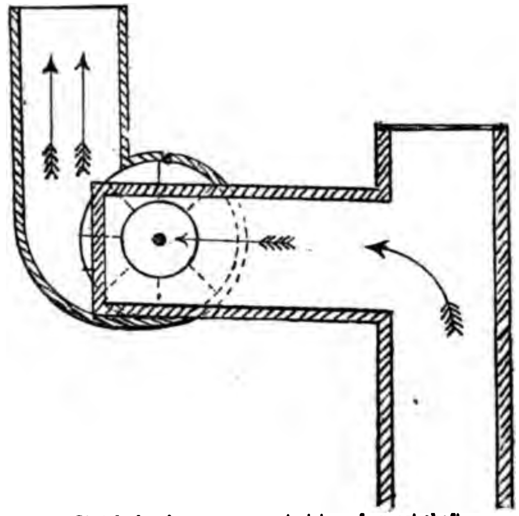
VENTILATION BY FAN AND FURNACE.

Question 1.—How is the ventilation of a mine effected by a furnace and how by a fan? Describe the arrangements of the upcast shaft in each case. Give sketches.



Sketch showing arrangement at bottom of upcast shaft ventilated by furnace.

Answer.—The furnace is placed a short distance away from the bottom of the upcast shaft, and produces ventilation by rarefying or reducing the density of the return air. The heat of the fire or furnace expands the air, makes it lighter, so that it ascends while the heavier air in the downcast descends to take its place. This is an effective system, especially for deep pits, but a fire in a mine is not only undesirable but in many cases dangerous, and the smoke from the furnace does damage to the shaft and to the surroundings of the colliery at the surface. Exhaust fans are placed at the top of the upcast, not over the shaft, but a few yards away, so that it will not get damaged. General Rule 3 of the Act requires that "Where a mechanical contrivance for ventilation is introduced into any mine after the commencement of this Act, it will be in such a position and placed under such conditions as will tend to insure its being uninjured by an explosion." The upcast shaft is covered at the top to prevent any surface air getting in, and a drift is made to the fan. The action of a centrifugal fan is this, when the fan revolves the air in it is carried round, but does not continue to revolve with the fan, but flies off at a tangent from the circumference. As the fan revolves the air which enters at the centre moves towards the circumference, where it flies off in accordance with the laws of motion, producing a partial vacuum in the centre of the fan to which more air rushes, thus keeping up a continuous

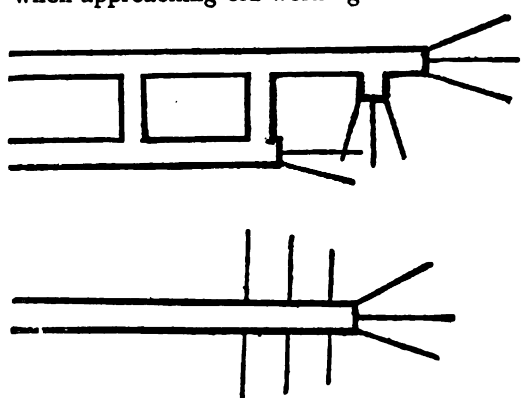


Sketch showing arrangement at top of upcast shaft ventilated by fan.

current. This exhausts the air in the upcast and causes a partial vacuum, upon which the air in the downcast descends and flows towards it. JAMES FINCH.

BORING TOWARDS OLD WORKINGS.

Question 2.—What precautions are necessary when approaching old workings?



Answer.—When approaching old workings it is necessary to have a pair of places in order to get the face ventilated. The sketch shows a pair of exploring places and the position of the boreholes. One place which is bored with three holes is kept a short distance in advance of the other one. Each stenton is bored with three holes and is driven from the leading place, and when it is a sufficent distance, the other or back place, which has been standing at the previous stenton, is commenced, and is bored with one front and one flank-hole, the latter on the side of the solid coal. In this way it is driven up until it holes into the stenton and so

completes another winning. When the plans and other circumstances indicate that the old workings are very near, and especially if a heavy pressure of water or gas is anticipated, it is usual to drive the fore or advance drift forward about eight feet in width and ventilate it with a brattice cloth. Two front or straight-on boreholes and the usual flankholes are kept in advance, and they are all, in most cases, increased in length as an additional precaution. Sometimes holes are bored at right angles to the drift to ensure a sufficient thickness of side coal, for it might happen that an old working place was running parallel to the exploring drift, but not near enough to be holed into by the flankholes. When boring towards old workings the following precautions should be taken:—Three or four firwood plugs ought to be kept dry and in readiness at the face of each drift. They are usually made from 4 to 6 feet in length, and tapered at one end to a point for easy entrance into the borehole when there is an outflow of water, the other end of the plugs are made larger than the diameter of the borehole, and are hooped with iron to prevent them from splitting when being driven into the hole. The driving of a wood plug into a borehole against a heavy pressure of water is sometimes both difficult and dangerous. A cross-piece is usually put through the plug near to the hoop to serve as a handle, and the plug may also be wrapped round with flannel and tar. A set of trying or measuring rods should be kept near to the face, so that the length of the borehole can at any time be known. This is necessary in order to avoid anything less than the minimum or statute limit of five yards of borehole being kept in advance of the drift. Safety lamps should be used while boring, and a spare lamp kept a short distance back from the face, so that if the borers' lamps become extinguished by a sudden outburst of water or gas on boring into old workings there will be another at hand. Sometimes when heavy pressures of water and gas are anticipated, boring is accomplished through a fixed pipe and valve at the mouth of the hole, and when a holing is effected and the rods withdrawn, all that there is to be done to prevent the outflow of water or gas is to close the valve; also a gauge may be fixed on the pipe to know the pressure of the water in the old workings.

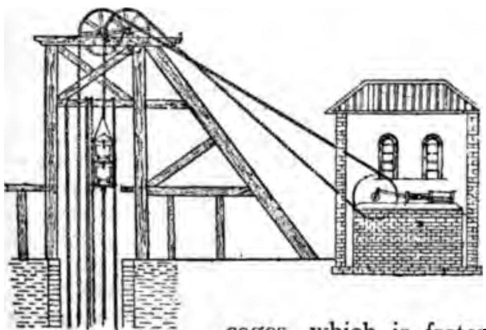
JAMES FINCH.

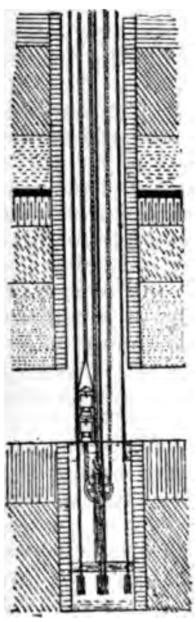
ADVANCED.

KOEPE'S SYSTEM OF WINDING.

Question 3.—What is Koepe's system of winding? Give sketches.

Answer.—The Koepe's system of winding is a method of running two cages with one rope, and a single pulley instead of winding drum or drums. This system consists of a single-grooved V pulley in place of an ordinary drum put on the engine shaft. The winding rope passes from one cage over its head-gear pulley and connected to the other cage. The winding rope simply passes half round the pulley on the engine shaft in the same manner as a driving belt on an ordinary pulley. This pulley may be described as a grip pulley, and it may be made after the manner of Walker's fleet wheel, Fowler's clip pulley, or a Climax V pulley, and it requires to be of greater strength than an ordinary one, because the shaft of the pulley is at the same time the main shaft of the engine. There is a balance rope beneath the





cages, which is fastened at the bottom of one cage, then round a pulley in the sump, and then up to the bottom of the other cage, so that the arrangement may be likened to an endless rope, the two cages being points of attachment. The drum or grooved pulley usually consists of two outside cases of an ordinary cylinder bolted together, and securing between them a band of hard wood, in which a groove is made to receive the winding rope, the depth of this groove being generally equal to twice the diameter of the rope. When the cage reaches the landing place and rests on the keeps or fallers the weight is removed from the rope, and sufficient adhesive power does not exist on

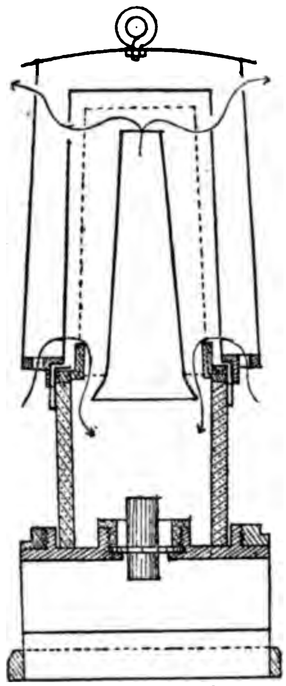
the rim of the motive pulley to enable the load to be restarted. This can be guarded against either by dispensing with keeps at the landing place, or by continuing the rope past the cage by means of cross-heads above and below each cage, connected together by cross-pieces passing outside. The bridle chains are hung from the top cross-heads, and when the cages rest on the props the weight of the winding and tail ropes still remains on the motive pulley. The head-gear pulleys are angled towards each other instead of being placed parallel, the object being to reduce side friction. The advantages claimed by Koepe's system are: 1st—No drum is needed, that being supplied by the pulley described above, therefore avoiding the enormous weight of massive winding drums to be stopped and started at each winding. 2nd—A smaller engine and engine-house is required. 3rd—The pulley not being so wide as a drum, takes up less room, and therefore a shorter crank shaft is needed, thus bringing the engines closer together. 4th—The rope always works in the same line. 5th—The rope always curls round the same diameter. 6th—Only one rope is actually used for winding, thus less rope is required in this system than in any other. 7th—It gives a perfect counter-balance. The disadvantages are: 1st—Cannot put the water-cages on to wind water in the night time out of the sump, on account of the pulley and weights in the sump. 2nd.—Cannot use one cage independent of the other in case of accident to one of them. 3rd—Cannot grease the winding ropes as often as required owing to the chance of the rope slipping on the grooved pulley with the ascending load. 4th—The difficulty of recapping, because there is no spare rope. 5th.—If the rope broke both cages would fall to the bottom of the pit, thus causing considerable damage. But an improvement has been made and two extra ropes have been employed, which are said to do away with this danger. In Germany a brake block has been placed on the pulley, which, in case of the rope breaking, is automatically wedged over the pulley and prevents the rope from slipping. This system of winding (in England) was first tried at Bestwood Colliery, Notts, but after seven years in use, it was abandoned in 1890, owing to the slip which took place, when the winding ropes had been fresh oiled. At this colliery such a slip was very objectionable, because winding took place at the upcast shaft, which was cased in all round so that the engineman could not see the cages, but had to rely entirely on the indicator. The second adoption of this system of winding in this country was at Sneyd Colliery, North Staffordshire. Its work has been and is most satisfactory, the sump pulley being weighted. This system of winding has been in successful operation since 1877, and results show that the single winding rope lasts more than twice the time of the two ropes formerly adopted. JNO. JONES.

The sketch shows one of the head-gear pulleys placed in advance of the other. This is not essential to the system as they are usually placed side by side, but it enables the tail-rope arrangement to be better seen in the sketch.—EDITOR.

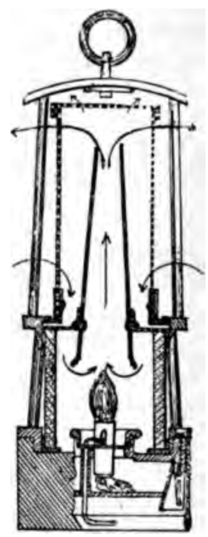
Sketch by H. HALL, Woodland, Co. Durham.

MUESLER SAFETY LAMP.

Question 4.—Describe with sketch the Muesler safety lamp.



Bonnetted Muesler.



Ordinary Muesler.

Answer.—This lamp resembles the Clanny. It consists of a glass cylinder at the bottom and a gauze cylinder above. It differs, however, from the Clanny in having a metal chimney, supported by a horizontal gauze diaphragm placed at the top of the glass cylinder. The air enters the lamp through the gauze, and the outside of the metal

chimney deflects the air down upon the flame. The chimney carries off the products of combustion and causes a good draught. When this lamp burns in a gaseous mixture, the formation of CO_2 gas is too rapid for its proper exit at the top of the chimney and the lamp is filled, thus extinguishing the light. This lamp—in one or two of its modifications—is alone permitted to be used in the fiery mines of Belguim, and the height of the chimney must be 4·6 inches, and it must have 3·55 inches of its height above the gauze diaphragm, whilst its base must be 0·85 inches above the flame.

The bonnetted Muesler has had a good repute for many years and is a very delicate detector of gas. It is not so suitable, however, for examining the roof, because of the metal chimney and the shield which acts as a shade.

Ashworth's Muesler differs from the ordinary Muesler, in having a gauze chimney instead of a metal one, and the diaphragm is conical instead of horizontal. Its safety is due to a double shield. The inner one is provided with a conical outlet; the products of combustion are retarded and the top of the gauze is kept in a bath of CO_2 gas.

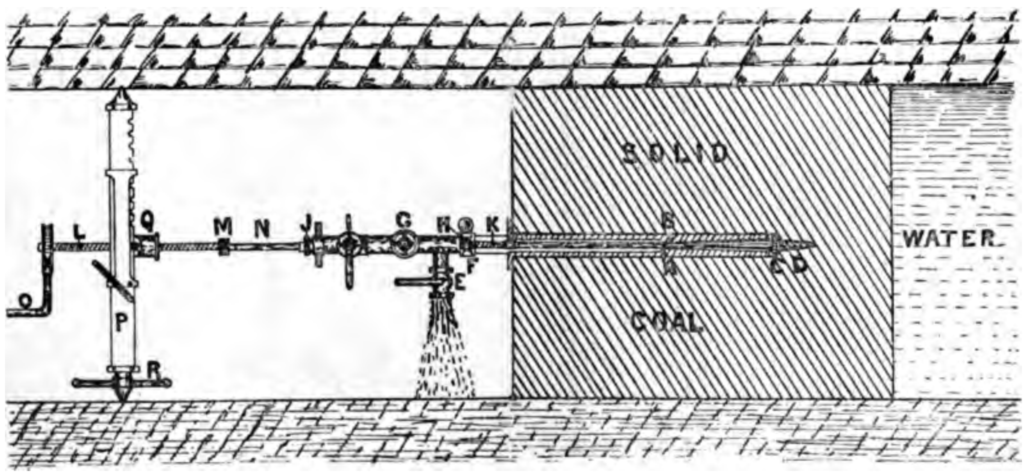
In the event of an internal explosion the light is extinguished. A gas testing shutter is placed near the top of the glass cylinder, and when this is closed, the air is compelled to enter through holes in the outside shield near the top, and this makes it possible to get at thin layers of gas near the roof.

R. FORSTER.

Sketches by H. HALL, Woodland.

TAPPING WATER FROM OLD WORKINGS.

Question 5.—If it was decided to tap a large accumulation of water from old workings how would you proceed and what arrangements would you make so that the flow of water would not exceed the pumping capacity of the pit? Give sketches.



A Lining Tube
B Iron Wedges
C India-rubber Washers
D Boring Tool
E Discharge Tap
F Cross-head Flange
G Clamp
H Nuts
I Stop Tap
J Stuffing Box
K Two Bolts
L Feed Screw
M Coupling
N Piston Rod
O Handle of Borer
P Stand for Borer
Q Feed Nut
R Tightening Screw

Answer.—I should proceed in compliance with the C.M.R.A., and in no case whatever would I make a breach of the above Act, but fully fulfil the provisions and enactments with reference to the approaching of old *workings.* I believe that the length of the boring required is inadequate as will be seen by the Act, which is as follows:—Where a place is likely to contain a dangerous accumulation of water, the workings approaching that place shall not at any point within 40 yards of that place exceed 8 feet in width, and there shall be constantly kept at a sufficient distance (not being less than 5 yards in advance) at least one bore-hole in the centre of the working and sufficient flank bore-holes on each side.

A distance of 40 yards from the old workings is sufficient where a correct survey has been made, but if the survey is very old the

distance is insufficient, probably the survey is not correct. If incorrect surveys are made great dangers arise, and to avoid those dangers the patent boring machine, which I shall endeavour to explain, should always be used. By the ordinary system of boring we have many proofs of great risks, because when the boring tool holes or penetrates, and there is a sudden outburst of gas or water, or both, the only resource is to withdraw the boring tool and close the hole with a plug, such a plan is at least dangerous and also impracticable; accidents of a serious and even fatal character occur under such circumstances. It is claimed for the apparatus which is here described that it is an expeditious method of effecting the boring of long holes against old workings, and it has been proved by practical experience that under this system it is possible to shut off gas or water under all circumstances and thus avoid all possibilities of danger. A very important feature of this apparatus is comprised in the iron wedges used for the purpose of securing the appliance. The erection and securing of the appliance ready for boring is completed in a few minutes.

At the commencement of the boring of each hole the machine is tested to a water pressure of 500lbs. on the square inch; therefore it is perfectly safe in boring against any possible head of water at all likely to be met with. It is not only safe, but is very economical—little time is spent in erecting the machine; also in boring, as it has been reported by the inventor, that this boring apparatus had succeeded in boring a hole 33 yards 2 feet in a seam of coal 4 feet thick, in eighteen hours, so that for tapping accumulations of water in old goaves it is of the utmost value.

The description of the apparatus is as follows:—The handle O is operated by manual or other power, and may be detached or attached to the feed-screw L whenever necessary. The feed-screw L is attached to the outer end of the piston rod N by means of the coupling M. The feed-screw L is worked through the feed-nut Q, which is screwed to the upright stand P, which is fastened to the roof and floor of the seam by means of the tightening screw R. The boring rods are inserted inside the tube to reach to the inner end of the piston rod N, which works through the stuffing box J, and is screwed on to the outer end of the tube. Should there be an outburst of gas or water from the bore-hole while the stuffing box J is disconnected from the tube for the purpose of attaching the required length of boring rods on the piston N, the gun-metal tap I is provided so that such an outburst can be turned off immediately. Should the outburst occur after the stuffing box is disconnected from the tube and the boring rods in the bore-hole are unable to be withdrawn, as in the case of a flank-hole where there is not sufficient room to withdraw the boring rods until unscrewed into their separate lengths, the clamp G and the screw are fitted with packing which is firmly pressed on to the boring rods by turning the two hand wheels so as to make the boring rods water-tight in the tubes. The tube marked A, the two iron wedges marked B, and the two supporting plates are inserted into the drill hole, the wedges and the plates being made to fit round the tube. The two iron wedges are inserted with the larger end inwards, and their outer ends attached to the cross-head flange F by the two bolts marked K. When the nut H is screwed up, the two wedges B are drawn outwards between the two supporting plates, and as a result, the supporting plates are locked by the side of the drill hole, and by continuing to screw the nut H up the tube A and having the india-rubber washer marked C on the inner end of the drill hole, this makes the tube, gas and water-tight. Then there is a discharge tap E, which, when open, allows the debris from the boring tool to fall on to the floor of the mine. The first operation is to bore an ordinary hole a little over 2 inches diameter to the depth of 4 feet into the coal, as shown by the boring tool marked P, after which the hole is enlarged to 4 inches diameter to a depth of 3 feet 6 inches into the coal. When the boring tool first penetrates into the old workings in which gas or water is confined, the presence of the accumulation is first indicated by the action on the pressure gauge attached to the machine. Now, to prevent the flow of water exceeding the pumping capacity when the old workings are penetrated, the discharge tap E regulates the water which is forced out of the old workings. Then if the water would not flow to the shaft bottom by gravitation, an arrangement of pipes should be laid down from the shaft sump or some other convenient place where the pump may raise it to the bore-hole, and then attached to the discharge tap E where the flow may be regulated, so that the water will not exceed the pumping capacity. Just one

word more with reference to the inventor and patentee of the apparatus. He is a hardy son of toil who had considerable practical experience in the manual operations of mining. Great credit is due to him amongst the mining community for preventing loss of life and the flooding of collieries, which too often result from holing into the old workings. The inventor is George Burnside, Fence-houses, Durham. JAMES DAVIES.

NOTICE TO COMPETITORS.

Some of our competitors have complained that those who have their questions criticised have an unfair advantage of knowing how they stand with reference to the Gold Medal Competition. We have, therefore, decided to discontinue these criticisms.—ED.

AWARDS

FOR ANSWERS TO COMPETITION QUESTIONS.—No. 8 SET.

ELEMENTARY.—James Finch, Green Lane, Hindley Green, near Wigan.

Commended.—J. H. Senior, R. Sherman, W. H. Hardy, R. Cherry, T. Webster.

ADVANCED.—John Jones, Pelydfryn, Aberderfyn, near Ruabon.

Commended.—S. Davies, J. Stephenson, J. Tuless, R. Turner, T. E. Aitchison, M. Monrley. Hy. Talbot, R. Forster, J. J. Wells, H. Bradshaw, J. Trow, W. Sutherland. W. D. Featherstone, H. Hall (Ryhill), W. Mitchell, J. Crone, H. Hall (Woodland).

FIRST-CLASS.—Jas. Davies, 98, Picton Street, Maesteg, Glam., S. Wales.

Commended.—W. Limbs, J. Harrison, J. McPhail, J. G. Bell. G. A. Hawes, W. Slocombe, T. Wallett, J. Hurst, M. Brown, A. Bedford.

CORRESPONDENCE.

We will publish a reasonable amount of correspondence per issue, but subject to the following conditions:—

To be written on one side of the paper only.

Envelopes to be marked "Correspondence."

Name and address of sender must accompany such correspondence as a sign of good faith, but the writer may assume a *Nom-de-plume* to be published if he so desires.

Correspondence must not be enclosed with Competition Answers.

The Editor will not hold himself responsible for any correspondence, nor will the publishing of it affirm that we hold the same views as the writer.

VENTILATION QUERIES.

Sir,—An answer to the following would oblige:—Height of water-gauge ·7, the length of airway trebled, and velocity increased from 8 to 10 feet per second. What is the height of water-gauge under altered conditions?—REYNARD.

Sir,—Will some of your numerous readers give this question an answer in "Mining," as follows:—Find the W.G., also the pressure and the H.P. to pass 90,000 cubic feet of air per minute through an airway 8 x 6. Show the thorough working of same.—CONSTANT READER.

PATENTS.

Dear Sir,—Will you or some of the readers of your valuable journal please answer the following question:—What is the manner or mode of securing a patent. If the invention is not patented will the money be returned or forfeited.—FAITHFUL READER.

THE C.M.R.A. AND CERTIFICATES OF SERVICE.

Sir,—Will you or some of your readers please answer the following question:—Previous to the passing of the C.M.R.A. if a person had been an overman only four years and the manager, to suit his own convenience, obtained a service certificate for the said overman (second-class), is he according to the Act a properly qualified person.—HOWKER.

ANSWERS TO CORRESPONDENTS.

A COMPETITOR.—Many thanks for information. We will attend to it.

H.G.—One book will not fill the syllabus of the Honours Stage of the S. and A. Dept., no more than one book will for the Colliery Managers' Examination. Hughes' Text Book, price 18s., is one we can strongly recommend as including the greater portion of the syllabus. This or any other book may be obtained from our office, post free, at the published price.

A LEARNER.—In answer to your query as to what instruments are required for drawing, the most essential are:—Ruler (preferably a parallel), bow pen for drawing lines and bow pen compasses. The following will also be found necessary in some instances:—Set square, protractor, and a few scales of equal parts. These will be found sufficient for general work. We have made arrangements with a leading firm of instrument makers whereby we can supply our readers with instruments at an exceedingly low cost. *See front page of cover.*

ANXIOUS.—My dear sir, there is no sound reason why you should not obtain a second-class certificate of competency. Your writing is exceedingly clear and legible and is infinitely better than many second-class certificated men with whom we are acquainted. As for drawing, with a few suitable instruments (see answer to "A Learner") you can undoubtedly manage after a little practice. If you are sufficiently well-grounded in the mining subjects proper you should have little trouble with the remainder. We are pleased you attribute your success up to the present to our journal.

Printed and Published by STROWGER AND SON, Clarence Yard, Wallgate, Wigan; also Published by JESSE SALISBURY, *48, Fleet Lane,* Farringdon Street, London, E.C., and JOHN HEYWOOD, Manchester.

No 9. Vol. III. SATURDAY, MARCH 23, 1895. FORTNIGHTLY. ONE PENNY.

CONTENTS.

EASY LESSONS ON

MINE VENTILATION.

By J. CARTER, First-Class Certificated Manager.

INTRODUCTION.

THIS subject is one of the most important branches in mining, and is certainly one which every mining student should thoroughly understand, as without such knowledge how can a student hope to become successful, especially in these modern times, wherein ventilation plays so important a part in our mining industry. Therefore, I have taken up this subject with a view to helping those readers of "Mining" who are not so far advanced in this subject, and will endeavour to point out clearly the principal laws which govern ventilation.

What is ventilation? It is the sending forth in our mines of a supply of fresh air and coursing it through the various workings and roadways in the mines below ground.

Why is ventilation necessary and so important? Because the lives of all persons and animals employed below ground depend on it for their sustenance and safety, and not only this, but the burning of lamps and the gases given off in the mine all require a constant supply of fresh air in order to keep the atmosphere of the mine in a fit state for men and animals to breathe in and to enable lamps to burn, thereby rendering the mine in such a state as to be workable with safety to all employed. The extent to which it must be employed shall be in accordance with the C.M.R.A., which says that an adequate amount of ventilation shall be constantly supplied in every mine to dilute and render harmless all noxious gases to such an extent as to render all working places of the shafts, levels, stables, and workings of the mine, and the travelling roads to and from those working places in a fit state for working and passing therein.

There are various methods of ventilation, viz., natural, waterfall, steam-jets, furnace, and mechanical ventilators.

I do not intend to dwell on the first three methods, because they are unsatisfactory. For instance, the current of air produced naturally will change its direction at times, and the upcast will become the downcast and *vice-versa* under certain conditions. A waterfall is sometimes used as an auxiliary to send air into the mine after an explosion. The steam-jets are still used in some old mines, but no one would think of employing such in our modern mines, because the result obtained therefrom would be inadequate for obtaining the quantity of air required in the majority of cases.

Furnace ventilation is produced by placing a furnace a short distance away from the

shaft you require for an upcast, and by its action the air is heated and rarefied, and as air becomes lighter for every degree of heat imparted, the greater the difference of the temperatures of the two shafts the greater amount of ventilation is obtained under similar conditions. Although this method has given and is giving good results, yet it is gaining less favour by many of our mining authorities and is being superseded by the fan for various reasons, which I am sure are very important ones, besides, the fan produces better results per quantity of coal burned as well as being much safer in the mine.

Objections to the use of the furnace are, repairs cannot be done while the fire is burning, therefore it has to be damped out, which means reducing ventilation, and in a gaseous mine the result is, that the mine becomes charged with gas, which has to be removed before commencing work again, rendering such work at times dangerous and difficult in extensive mines. Besides this, it not unfrequently happens that there are several mines from different shafts dependent upon this furnace and shaft, therefore if the repairs are such as will take several days, which has been the case many times, other mines have to cease work as well until the repairs are completed, whereas by fan, the ventilation would be going on as usual, and the other mines would not be interfered with but could go on working during repairs. These observations have frequently come under my notice, and oftentimes I have had the supervision of clearing such mines after repairs have been completed and have found it a difficult and dangerous task.

It is injurious to the shaft fittings, such as pipes, tubbing, beams, and in fact the ropes, rods, and to a certain extent the plant on the surface becomes damaged. The shaft and fittings are more difficult to inspect owing to dirt, etc., which accumulate on the sides of the shaft and on the various fittings therein from the clouds of smoke which are constantly issuing forth from the furnace and making everything black and dirty on the surface near the upcast shaft. Fires in mines are also very dangerous.

These objections are removed by the use of the fan for ventilating purposes, therefore, there is no wonder that mining authorities have of late years turned their attention to mechanical ventilation, and as I mentioned before this method is now superseding furnace ventilation. Its advantages enable any repairs to be done and the inspection of the shaft and fittings can be made without interfering with the ventilation; no danger to shaft, fittings, or surface plant, and a greater percentage of useful work.

The fans now used are chiefly exhaust fans, and there are a large number of them on the market at the present time, all claiming to give excellent results; some of these I will deal with further on.

(To be continued.)

COMPETITION QUESTIONS.

No. 12 SET.

To the sender of the best set of Original Answers in each Stage will be awarded the following:—

Elementary 2s. 6d., Advanced 3s. 6d., First-Class 4s. 6d.

A Competitor may only answer one Stage. The best answer to each question will be published with the sender's name and address.

1.—All envelopes must be marked "COMPETITION."

2.—To be written on separate sheets of paper with name attached, and on one side of the paper only. Sketches to be in ink (Indian ink preferred) on *unruled* paper.

3.—Correct name and postal address must be sent.

4.—They must reach us by April 5th, 1895.

5.—The Editor's decision as to winners to be final.

ELEMENTARY.

Question 1.—State in your own words what use the science of geology is to coal mining ?

ADVANCED.

Question 2.—How is water dammed back in shafts by coffering ?

Question 3.—How would you support the coal while holing in dirt, 18 inches thick, in a mine 4 feet thick, working longwall upbrow, rising 1 in 5. What distance apart should the supports be set ?

FIRST-CLASS.

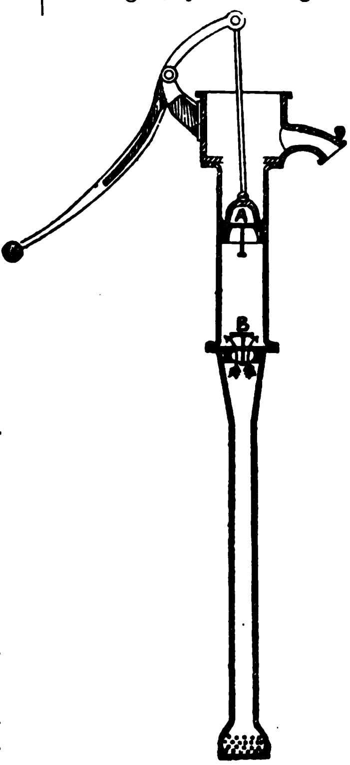
Question 4.—If the return airway of a fiery mine was completely blocked up by a fall, how would you proceed ?

Question 5.—How would you prevent the accumulation of gas in a high cavity in the roof of a main roadway ? Give sketch.

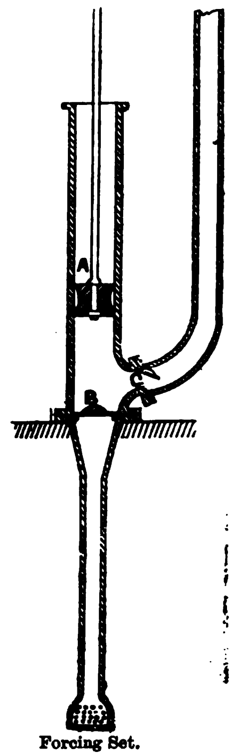
PUMPS & PUMPING.

By J. STEPHENSON.

PUMP is the general name given to any hydraulic machine for raising water. All pumps may be classed into three divisions—the common pump (atmospheric), the lifting pump, and the forcing pump. The common pump consists of a cylindrical body or barrel, from which extends a tube into the water contained in the well or reservoir. In the interior of the cylinder is a movable piston, which is surrounded with leather, in order that it may be water-tight, yet capable of moving up and down with freedom. The piston is perforated, or a hole is bored in the piston, the same being covered by a valve which opens upwards; a similar valve is placed at the bottom of the cylinder or barrel covering the upper extremity of the tube which leads to the well. The mode of action is as follows:—Let us suppose the piston has reached the extremity of its downward stroke, and that it is in the act of ascending, being fitted air-tight a vacuum is left below between the piston and the valve at the bottom of the cylinder, when the pressure of the air acts on the surface of the water in the well, with a force of 15lbs. on the square inch. The water transmits this pressure equally in all directions, and finding, in consequence of the vacuum, no force to oppose it at the bottom of the tube in the well, it rises in the tube, and could a perfect vacuum be obtained it would rise nearly 33 feet. In practice the tube is never longer than 28 feet, and the water being forced to rise through the pressure of the air and the equal transmission of of pressure by fluids, passes through the valve at the bottom of the barrel and fills it, when the piston, coming down into the water, the falls or valves of the piston are forced open, the weight of the water shuts the lower valve, and the water passes to the top of the piston, then the latter being lifted up the two valves will evidently close, and the water will pass out at the spout or delivery. The lifting set:—This consists of windbore, clack-piece with clack or valve, working barrel, bucket and bucket-piece, pumps or stocks, and rods or spears. The windbore is a cast-iron pipe closed at the bottom, and perforated with holes for a distance of about 4 feet. The clack-piece is a cast-iron pipe made specially for the clack, with a door through which the clack may be changed. The clack is made of brass or iron, jacketted with leather or gutta-percha, having butterfly valves of wrought-iron plates and leather. The working barrel is made of cast-iron, generally lined with brass or gun-metal, and is usually bolted to the top of the clack-piece; its length depends upon the length of stroke given to the bucket. The bucket consists of an iron shell or hoop, surrounded by leather or gutta-percha, so as to fit the working barrel, its valves are similar to those of the clack working on a hinge in the centre of the top of the bucket. The bucket-piece is a door at the top of the working barrel by which access is gained to the bucket. The pumps or stocks are cast-iron pipes carried from bucket-piece to the surface; they are about 9 feet in length and about an inch larger in diameter than the working barrel; these are provided with flanges, and secured with nuts and bolts. Spears are generally made of pitch-pine, in pieces of from 30 to 45 feet in length, joined together with wrought-iron



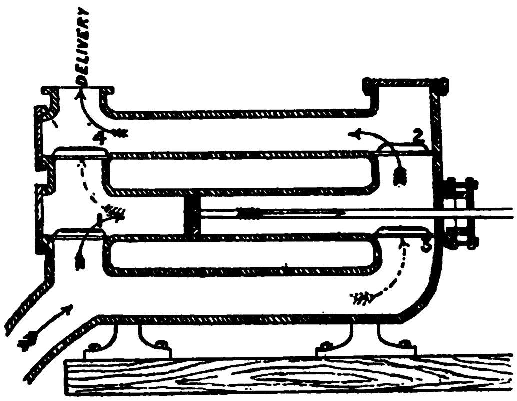
Common Pump.



Forcing Set.

plates, these connecting the bucket to the engine. The height from the sump to the bucket, when at the top of its upstroke, should not exceed 25 feet. Its mode of action is similar to the common pump, depending

on the pressure of the atmosphere. When the pumps are filled as described in the common pump every upstroke of the bucket delivers water at the surface, the quantity depending upon the length of stroke and the size of pumps. Thus the suction depends upon the atmosphere, and the lifting upon the strength of the engine. The forcing set:—Here the piston, or what is termed the bucket in the lifting set, has no valve, but a valve is placed at the entrance into the body of the pump of the tube of ascension.



Joicey's Portable Double Mine Pump.

The water is raised above the lower clack as before, but when in the body of the pump (that is the space between the clack and the piston at its highest range), the piston in descending forces the water, not through the piston, but up the ascension tube. The construction of this pump may be explained in the following manner:—The ram or plunger works through a stuffing-box, also a delivery clack which supports the column of water by being shut when the suction valve is open. The difference of the action between the lifting and forcing pumps is, that the lifting pump will cause a vacuum and the water will then rise to a height of about 20 feet, as in the atmospheric pump. The lifting bucket then descends into the water thus raised, and on its ascent it lifts the whole column of water in the pipes and discharges a quantity equal to the length of the stroke, whilst the water in the plunger or forcing pump is made to rise, after it has also been raised to a height of about 20 feet by the atmosphere, by a ram or plunger coming down with great force and displacing the water. The pumps described have the engine at the surface. Another kind of pump is the direct-acting pump, which is placed at the pit bottom. It consists of two cylinders and one piston-rod, with a piston at each end. When the piston-rod travels to the right water enters the water cylinder. When the return stroke is made the water is forced up the *pipes to* the surface. A good arrangement for pumping water out of dip workings is Joicey's portable double mine pump. This consists of a suction pipe, pump barrel, piston and piston-rod with stuffing-box, four clacks, connecting rod, and driving wheel. Its action is as follows:—When the piston travels to the right the water is drawn through the suction pipe and No. 1 clack, and when the return stroke is made this one is closed and No. 4 opened, forcing the water through the delivery pipes, at the same time No. 3 is opened, and water follows the piston, then in returning No. 3 is closed, and No. 2 is opened to the delivery. Thus, with a continuous motion, two clacks are open and two shut. This class of pump may be worked by the main and tail rope, if the rope be passed round the driving wheel. Electricity is being largely introduced to work pumps at long distances from the shaft. With electricity no large pipes or heavy ropes are needed, all that is required for transmission of power is a small wire cable. This is most convenient for taking round corners and for lengthening, and the long distances traversed cause only a very slight diminution of power; therefore it is when pumping is required at great distances from the pit bottom that electricity especially recommends itself.

AWARDS

FOR ANSWERS TO COMPETITION QUESTIONS.—No. 9 SET.

ELEMENTARY.—John Henry Senior, 16, Thompson Row, High Street, Rawmarsh, Rotherham.

Commended.—T. Webster, J. Wheatcroft, A. Proud, F. Cherry, T. Lawrenson, J. H. Hutchinson, J. Mills, F. King, S. Bottoms, M. Collinson.

ADVANCED.—G. Bell, Shotton Colliery, *via* Castle Eden, Durham.

Commended.—H. Hall (Woodland), W. Mitchell, J. Crone, Henry Hall (Ryhill), S. Davies, T. E. Aitchison, M. Mourley, J. Stephenson, J. P. Donohue, H. Bradshaw, J. Craggs, H. Talbot, C. Carter, T. Hill.

FIRST-CLASS.—William B. Foster, Tudhoe Colliery, Spennymoor.

Commended.—M. Brown, J. G. Bell, W. Slocombe, G. A. Hawes, G. Daykin, J. Harrison, J. McPhail, J. Davies, J. Jackson.

THE ENGINEERING OF COLLIERIES

Being a Treatise on Colliery Machinery, Appliances, and Constructions.

By T. A. O'DONAHUE.

Winding.

It is essential for the economical loading, cleaning, and sorting of the coals, that they should be raised a considerable height above the surface level, and a pit bank or raised staging is usually constructed about 20 feet high on which to land the coals. The coal is raised by means of powerful winding engines which drive a large drum, round the circumference of which a wire rope coils. The rope passes from the drum over a pulley, which is fixed on a framework or headgear to the cage in which the load is wound. Almost all modern collieries are fitted with two cages in the one shaft so as to effect a counter-balance, two pulleys and two ropes are thus necessary, and the ropes are coiled on the drum in different directions, so that one cage descends while the other ascends. The winding drum is usually of large diameter, many having a circumference of 60 feet, and as it is coupled direct one stroke of the engine will cause the cages to travel a distance of many feet. This, added to the fact that the banking stage is about 20 feet high, and the cages contain two and in many cases three decks, renders it necessary in order to prevent overwinding that the headgears should be of great height.

It is of the utmost importance that the headgear be substantially constructed and sufficiently strong to bear all the strains which may be put upon it; for its destruction would stop the working of the pit for a considerable period. The headgear comprises a pair of main legs, a pair of front legs (both vertical in side elevation), and a pair of backstays with suitable cross-pieces to connect and strengthen them, and is usually made of timber (pitch-pine), but more recently iron and steel have been largely used. The main posts upon which the pulleys rest, for ordinary arrangements and double-decked cages, should be about 60 feet high, and the distance between the legs at the top is such as will allow of the two pulleys being properly fixed a distance apart equal to that between the centres of the cages, and are widened out at the bottom to give stability to the structure. The inclination of the front legs towards each other is made to correspond with the main posts, and the distance between the front posts and the main posts, from centre to centre, is the same as the rope diameter of the pulleys which are to be used, so that the ropes will hang exactly midway. The width of the backstays at the top will of course be the same as that of the main posts, and they widen out at the bottom in a similar manner.

The angle which the back stays make with the main posts depends upon the relative positions of the winding drum and the pulleys. There are two strains to be counteracted in the the construction of the head-gear, viz.:—The weight of the cages, tubs, coal, etc., constituting the load, and the tension of the ropes from the drum to the pulleys, which strain will be exactly equivalent to the load. There are thus two equal strains acting at a definite angle from each other, and if we desire to find a resultant line along which the combined forces may be said to act, and which would be the best position for *one* support to counteract the two forces, we have simply to construct the parallelogram of forces. Thus let us assume A (fig. 1) to represent the

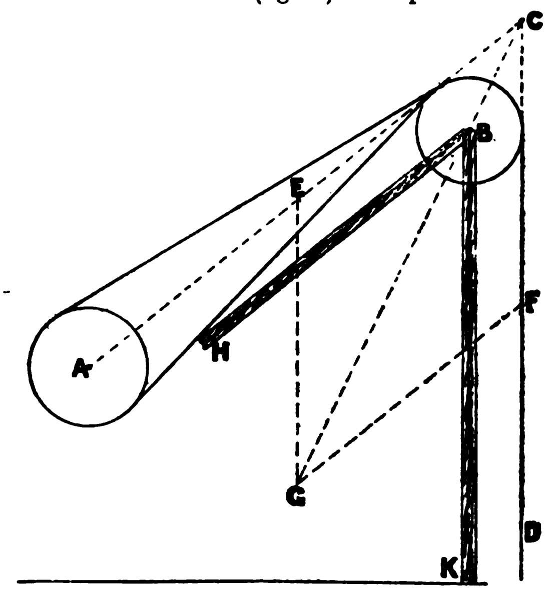
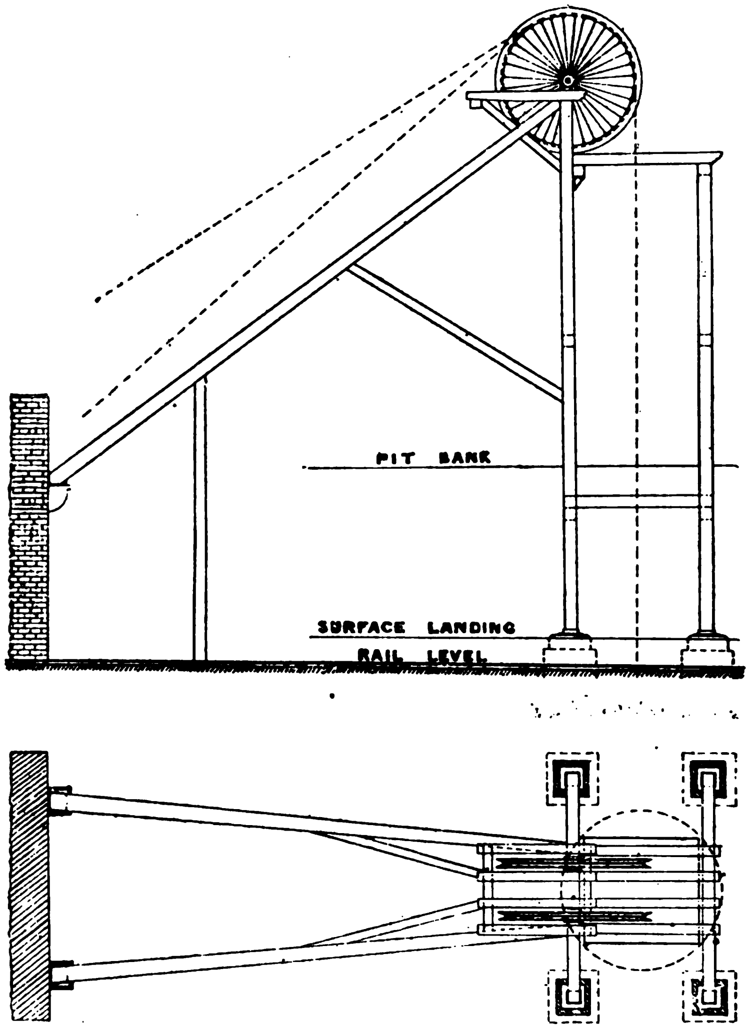


Fig. 1.
Showing the theoretical position of Backstays for Head-gear.

winding drum and B the pulleys. The line along which the strain, from the drum to the pulleys, acts may be taken midway between the ropes (*i.e.* to the centre of the drum) as A C, and the strain accruing from the weight may be taken as along D C. Now as the strains are equal mark off equal parts along C A and C D as shown at E and F. Through E draw E G parallel to C F, and

through F draw F G parallel to C E join C G. The line C G thus obtained is the resultant of the two forces acting along C A and C D, and bears the same relation with regard to magnitude to the other two forces as the length of the line C G does to the lines C·E and C F. To make this clearer assume the strain along each of the lines C A and C D to be 8 tons, and let C E and C F be marked off with a scale of equal parts, eight divisions. We now find by construction that the line C G measures 14·5 *on the same scale, and from this we know that the two forces or strains of 8 tons each in the directions C A and C D are equal to a strain or force along C G of 14·5 tons. As we have previously stated this line C G would be the best position for *one* support to conteract these two strains as a stay capable of supporting 14·5 tons would be sufficient to neutralise the two strains of 8 tons each. But by the converse of the parallelogram of forces we may resolve one force into two, or if there be two forces acting on a point we may neutralise each force separately, and this is exactly what is done in the construction of a headgear, as it is the most practical under the circumstances. Thus in the example the vertical stays B K counteract the strain along C D, and it requires little consideration to enable us to see that if there is a strain on the point B in the direction of the line C A that the best possible position to place a stay to counteract this strain is parallel to it as shown by B H. The front posts which are usually added to the headgear do not come into our calculations, as theoretically they do not help to counteract the two strains with which we have been dealing, though as a matter of fact they tend greatly to make the whole construction more stable. The principal other duty which they have to perform is to support a portion of the guide rods. We have dealt somewhat exhaustively on the proper position of the back stays, because some writers in their endeavour to find the position by the parallelogram of forces, have fixed the theoretical position of the back stays along the resultant of the two



Figs. 2 & 3. Elevation and Plan of Head-gear.

PRINCIPAL DIMENSIONS OF ABOVE HEAD-GEAR.

Pulleys (rope diameter)	14 feet 6 inches
Height of Pulley Bearings above rail level	64 feet 0 inches
Height of Surface Landing above rail level	2 feet 9 inches
Height of Pit Bank above rail level	21 feet 6 inches
Distance between Main Posts at top (centre to centre)	9 feet 0 inches
Distance between Main Posts at bottom (centre to centre)	24 feet 0 inches
Distance between Back Stays at bottom (centre to centre)	19 feet 6 inches
Distance between Pulleys (centre to centre)	5 feet 9 inches
Distance between Engine-house and centre of Pit	65 feet 0 inches

SIZES OF TIMBER, &c.

Bottom of Vertical Posts	18 inches by 18 inches
Top of Vertical Posts	16 inches by 16 inches
Bottom of Back Stays	20 inches by 20 inches
Top of Back Stays	12 inches by 12 inches
Foundation Stones	3 feet 6 inches by 3 feet 6 inches by 1 foot 6 inches
Brick Pillars	6 feet by 6 feet

* It must be understood that this number is only true for the angle we have taken, and it is not constant.

forces, that is along C G in our example, evidently overlooking the fact that one force is already provided for by the main posts. They would doubtless, from this method of reasoning, attempt to prove that in the above example the backstays would be required to counteract a strain of 14·5 tons, whereas we have shown that they have only to counteract a strain of 8 tons.

Figs. 2 & 3 show the construction of a headgear which has recently been fitted at a colliery with which we are acquainted to wind cages of two decks, three tubs in a deck. The quantity of coal wound each time being about two tons. To give the main and front posts a good foundation, as this is of especial moment, pillars of brickwork, 6 feet square, were erected on a bed of concrete; these pillars were then surmounted by large blocks of stone, to which were bolted the cast-iron shoes, into which the posts fitted. The backstays were supported on abutting stones from the engine bed.

Fig. 4. Illustration from photograph of Steel Head-gear.

The position of the stays and cross-pieces are practically the same for a headgear of iron or steel as of timber. The legs and backstays of steel headgears are usually constructed of lattice work. The lattice work consists of four angle irons, connected diagonally by flat strips. The illustration (fig. 4) is from a photograph of the pit headgear erected at the Newhall Park Collieries, by Messrs. Thornwill and Wareham. The pulleys are 15 feet diameter and are 40 feet from the ground. A greater height than 40 feet was not necessary under the circumstances, as the tubs are banked on the ground and not on a staging. The iron shoes at the base of the legs and back-stays are clearly seen in the illustration.

(To be continued.)

ANSWERS TO QUESTIONS.

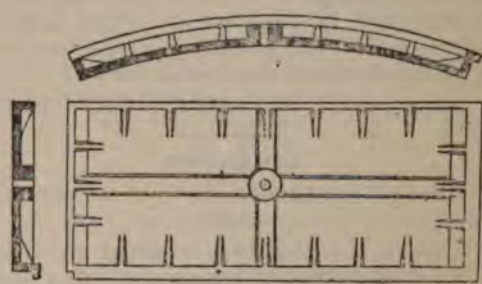
No. 9 Set—In No. 6, Vol. III.

ELEMENTARY.

METAL TUBBING.

Question 1.—How is water dammed back in shafts by metal tubbing? Give particulars with sketches of a segment of tubbing. What is the usual thickness of the metal employed?

Answer.—Metal tubbing becomes necessary in shafts when the sides have to be sustained against a high pressure, such as water, quicksand, and different kinds of pressure. When metal tubbing has to be used, a smooth and level bed is made and a tubbing crib put down, the segments being laid together end



for end, with a thin sheeting of wood between the joints and the whole securely wedged, the space behind is then packed with blocks of wood. The tubbing plates, after having been tested on the spot by hydraulic appliances, are sent down in segments and laid on the crib. The segments of tubbing for pits

were formerly made with the flanges on the outside of the sweep, so that the tubbing when viewed from the inside of the shaft presented a smooth face, like stone work. This was a good arrangement when corves were running in the shafts without guides, but the flanges are now on the reverse side, viz., on the shaft side instead of the rock side. Tubbing is put down in segments, of different lengths, the number varying so as to make the circle depth, which is generally 2 feet. The back of each plate is constructed with brackets for strengthening, and is 1 inch or 1½ inch thick, 20 inches to 24 inches broad, and 6 inches or 8 inches deep. A hole is provided in the middle of each to allow the water to pass through while the operation of laying the plates is proceeding. The top and one of the side flanges are provided on the outside with a projecting ledge, which keeps the joint sheeting and adjoining segments in position. A thin sheeting of wood is placed between all joints, vertical and horizontal. Each joint has flanges behind, 14 inches by 1 inch, all round the plate, and must be put off and on with each other. When there is no escape pipe near the top it is called close-topped tubbing. As the pressure is always greatest at the bottom of a column, the thickest plates are put at the bottom and reduced every few courses upwards. Sometimes they are of one thickness throughout. The Kind Chaudron tubbing is of extra thickness, and each ring is generally about 4½ or 5 feet in height. The lowermost ring is 2⅝ inches thick and weighs about 11¾ tons. The thickness must never get below ⅝ inch. The strength of the tubbing in pit shafts can be easily found by the following rule:—The radius of the pit in inches × the pressure per square inch in pounds, due to the head of water, and ÷ the pounds in three tons, will give the thickness required in inches.

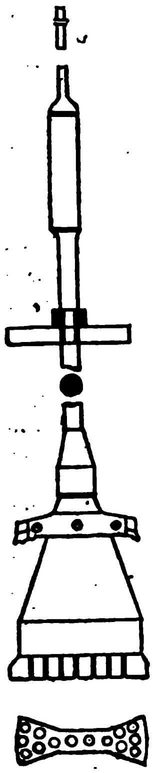
JOHN HENRY SENIOR.

ADVANCED.

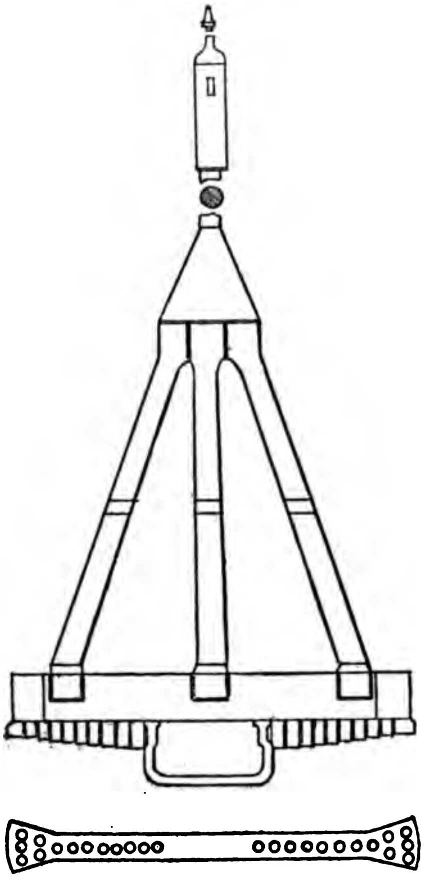
THE KIND CHAUDRON METHOD OF BORING SHAFTS.

Question 2.—Describe in detail the Kind Chaudron method of boring and lining shafts in watery strata. Give sketches.

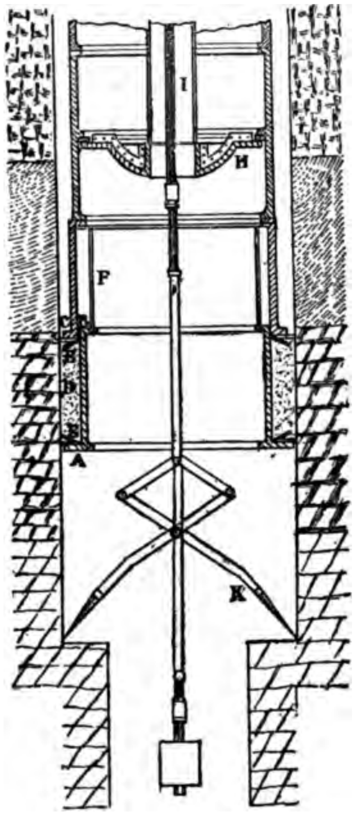
Answer.—The Kind Chaudron process of boring is intended for large wells and shafts. A small borehole is the same in principle as a large shaft, that is, they are both cylindrical holes, which only differ from each other in the size of their respective diameters, so it will at once be noticed that some special tool will be required for boring a large hole or shaft. The tool here used is called a trepan. This system possesses an important advantage, viz., that the work is carried on with the water at its natural level, and is quite independent of the quantity of water, which would have to be pumped by the ordinary method, thereby avoiding great expense and the difficulties of pumping when passing through watery strata. The Kind Chaudron system can be applied and has proved successful in all kinds of ground in which boring can be easily done. Running ground is difficult to bore through, although the dangers are not so great as by the ordinary method, because the pressure of water in the pit during the sinking prevents, in a marked degree, the sand or other loose rock from coming into the shaft. When passing through running sand or loose ground by this system it may be held back by a sheet-iron tube. The first operation is the erection of the necessary machinery on the surface, which consists of two engines—a horizontal engine for raising and lowering the boring tools by means of a hempen rope, 15 inches broad and 2½ to 3 inches thick; a vertical engine with a 39 inch cylinder for working the enormous brakestaff. The connection between the brakestaff and the piston rod is made by a large flat linked chain, the steam being applied above the piston only. The engineman works the handle by hand for every stroke, like a steam hammer, and the downstroke is caused by the sudden opening of the exhaust valve and the weight of the trepan and rods. A frame, acting like a spring beam, prevents the brakestaff going beyond its stroke and lightens the shock on the boring rods. The brakestaff lies with its axle loose in the carriage, and when lowering and raising the rods, by means of a roller placed under one end of the brakestaff and by hanging the hempen rope on the pit end of it, it is lifted by the engine out of its bearings and run back out of the way; when wanted again the operation is reversed. There are four platforms, the first is the pit heap, or main staging. Ten feet below this there is another platform, in the pit, where the men change and turn the rods; from this platform there is a road to the vertical engine. Immediately beneath the rope pulley there is a third platform, on which travelling rails are laid. Small travellers work on these rails, and there is one traveller for each length of rod. A traveller consists of two



Small Trepan.

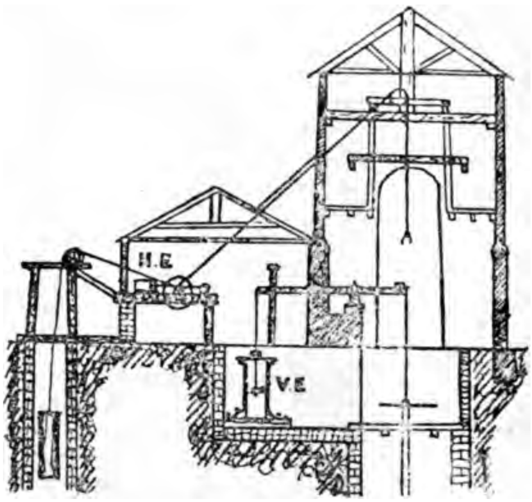


Large Trepan.



Section of Shaft showing Tubbing.

wheels with a strong iron axle, and on this axle there is a pair of stout jaws, between which a length of rod is secured by means of a pin. The rod is then detached from the rope and the traveller is run off to one side by two men; by this arrangement the heavy rods are moved about with great ease. At a height of 20 feet above the main staging there is the fourth platform, with a travelling way, on which very strong bogie travellers are used; to these the trepans and sludgers are attached by means of chocks and keys. A bogie is moved with a trepan on it by means of the men swaying the trepan and giving it a swinging motion. The men take advantage of this and at each forward motion of the trepan they give the bogie a push; two or three pushes take the trepan to where it is wanted. The bore rods are in 57 feet lengths and consist of pine wood, 7 to 8 inches square, tapered at the ends to receive the V plates of the iron screw joints, which are secured with iron bolts and hoops to the wooden rods. To the bottom length of wooden rods a short length of iron rod is attached, then the trepan. The boring tools generally consist of two trepans, a small one, from 3 to 5 feet, and a large one, from 10 feet to 13 feet in diameter. The small trepan weighs from 8 to 9 tons, and consists of a solid wrought-iron head, containing 14 cylindrical holes, into each of which a cutter or tooth is secured by a pin entering through a circular slot; the teeth are steeled. At a distance of four feet above the boring head there are four wrought-iron arms, curved at the ends, so as to allow the curve or bow to scrape the sides of the hole and take off any slight projection. At a distance of 13 feet above the boring head two guides, made of oak or iron, are fixed at right angles to each other. The small trepan bores through the strata before the large one is used. Sometimes the small one bores the whole distance, while in some cases it only precedes the large one from 5 to 15 fathoms. There is no fixed distance, but the small hole must always be a few yards in excess of the length of the



H E Horizontal Engine **V E** Vertical Engine
Surface Arrangements

sludger in advance of the full size of the pit, as the sludger is lowered into the small hole and remains there to receive the debris from the large trepan. The large trepan is forged in one solid piece, weighs about 16 tons, and has 26 cutters. In some cases it is fitted up with an iron projection, which enters the small hole and acts as a guide. At a distance of 7 feet above the teeth a wooden guide is sometimes fixed on the frame, and at 13 feet above two other guides are fixed at right angles to each other. The connection between the trepan and the rods is not a solid one, but resembles two large links sliding one within the other, allowing the rods to fall 8 inches after the tool strikes the bottom; this to some extent lessens the concussion on the rods. The teeth of the large trepan are not horizontal but are deeper towards the inside of the pit; the object of this is to cause the debris to drop at once into the small hole. Shafts which are sunk by this system are perfectly vertical. When the boring is completed the pit still requires to be tubbed, and it is at this point of the work which specially characterises the system. The tubbing consists of a moss-box and a series of cast-iron rings. The moss-box is made in the following manner: The ordinary tubbing terminates at the bottom with a flange turned outwards, a movable ring, whose exterior diameter is rather less than the interior diameter of the tubbing, is fitted on the lowest segment and has a flange at its base also turned outwards so as to correspond to the former. The space between the two flanges is filled with moss, well freed from earth, tightly rammed in and held by a net. The moss-box hangs on short sliding rods, fixed to the lowest segment of the tubbing. Each ring of tubbing is from 4 to 6 feet high and generally from 10 to 12 feet in diameter. It is cast in one piece to the thickness required and is furnished at the top and bottom with an inside flange, 4 inches broad. The rings are joined together by means of screwed bolts, and much care is needed in making and joining them, for if any little defect is discovered after the tubbing is in its place it is very difficult to repair. Each ring is tested to the pressure to which it will be exposed. The weight of the tubbing is partly borne by six rods, which pass through holes in one of the flanges and are lengthened at the top. The second ring above the moss-box has a special flange inside, to which a small segment of tubbing is attached. On to this a concave plate of cast-iron is bolted with the convex side down. In the centre of this plate there is a hole to admit a water tube, 16 inches in diameter. Cocks to admit water into the inside of the tubbing from the tube are placed at intervals, so that near the bottom of the tubbing is kept water-tight and floats in the pit amongst the water, the greatest portion of the weight of the tubbing being buoyed up by the water. After the tubbing has been lowered to the bottom the moss is compressed between the rock and the moss-box to such an extent that it makes a perfectly water-tight joint. The space behind the tubbing is now filled up with concrete, made of hydraulic lime, good sand and cement, and must be finished quickly. The cement is inserted with ladles, capable of holding 44 gallons. When it is finished a few days are allowed to elapse to give it time to set hard, after which the water is pumped out of the tubbing and the joint between the moss-box and the rock bed is then examined. In some cases the joint is thought sufficient, but generally it is desirable to form a base to the tubbing by building a few feet of brick-work on a wooden crib. Two wedging cribs are put in and four or more rings of tubbing, these coming close against the bottom of the moss-box.

G. Bell.

FIRST-CLASS.

Lancashire Boiler.

Question 3.—Describe with neat sketches the necessary fittings for a Lancashire boiler.

Fig. 1.
Pressure Gauge with Syphon

Fig. 2.
Dead-weight Safety Valve

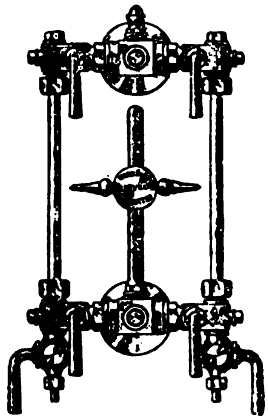


Fig. 3.
Two sets of Water Gauges with Index for Water Level

Answer.—The fittings I should consider necessary, and which I should prefer to use for a Lancashire boiler would be as follows:—Two sets of water gauges (glasses, cocks, &c.), one Bourdon's tube steam gauge and syphon tube, one feed valve and Hopkinson's low water safety valve, one dead-weight safety valve (Cowburn's), one stop valve and perforated internal pipe, and a safety plug in the crown of each furnace tube, also a pointer between the two gauges indicating the proper working level of water, and one blow-off

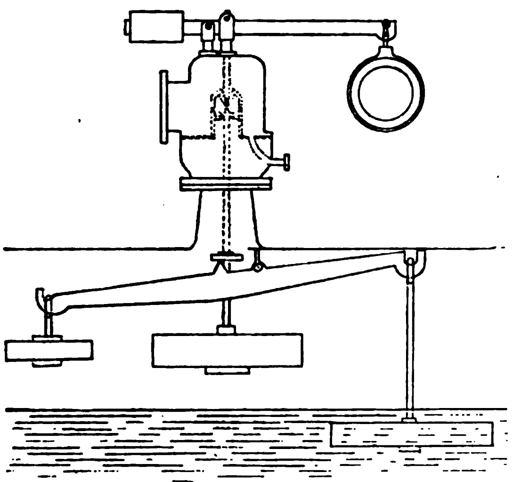


Fig. 4. Hopkinson's High-pressure and Low-water Valve.

cock; if the water was of a dirty nature I would have scum cocks in addition to the above. Fig. 3 represents the form of water gauges I would adopt, my reason for having two being that in case of a breakage of the glass of one of them or other accident, I should still have one to rely upon. I would have them asbestos packed and fitted with check valves so that all steam and water would be stopped if a glass broke, and there would be no danger of anyone getting scalded, &c. In these abestos packed cocks the barrel has grooves running down in which asbestos is tightly packed, and the plug of the cock pressing tightly on the asbestos keeps it perfectly water and steam tight. Fig. 1. *Steam Gauge and Syphon.*—I consider these tube gauges are a necessary fitting and the syphon filling with water keeps the gauge cool, &c. *The Feed Valve.*—I should have a wheel and screw and the valve loose and separate from the spindle, the wheel and screw to regulate the lift of valve to suit the quantity of water required in the boiler. *Stop Valve and Perforated Pipe.*—I would also have a wheel and spindle with screw, and the valve attached loose to the bottom of the spindle to open or shut off the steam as required. To the bottom of the stop valve inside the boiler I would have a perforated pipe or box, the perforations on the top side of the pipe to stop the tendency of priming. *The Dead-weight Safety Valve.*—Fig. 2.—This simply consists of an ordinary valve with a casing hanging on it, weighted so that the valve and attachments equal the total pressure on the whole area of the valve; therefore there would not be any lever for any one to

tamper with or get fast in its place or magnetised. *Hopkinson's Low Water Valve* (fig. 4).—In this valve a lever descends into the boiler, on one end of which hangs a float, and on the other a counter-balance. A vertical rod leading up to a cylindrical valve is fixed to the lever. The float is adjusted to low water mark, and directly the water gets below the mark the float falls, turning the lever, lifting the rod and valve, and allowing the steam free escape. *The Blow-off Cock.*—I would have this cock asbestos packed and fitted with a cap on top for locking it. By this I mean that the key could not be removed if it was open; the key would be off when shut, and I would then know that the cock was all right and shut. *Scum Cocks*—I would blow the scum off at short intervals so that it would not settle to the bottom of the boiler and form scale, thereby losing a lot of heat and perhaps damage the plates.

WILLIAM B. FOSTER.

INSPECTION OF A LANCASHIRE BOILER.

Question 4.—How would you prepare for a thorough inspection of a Lancashire boiler, and to what points would you more especially direct your attention?

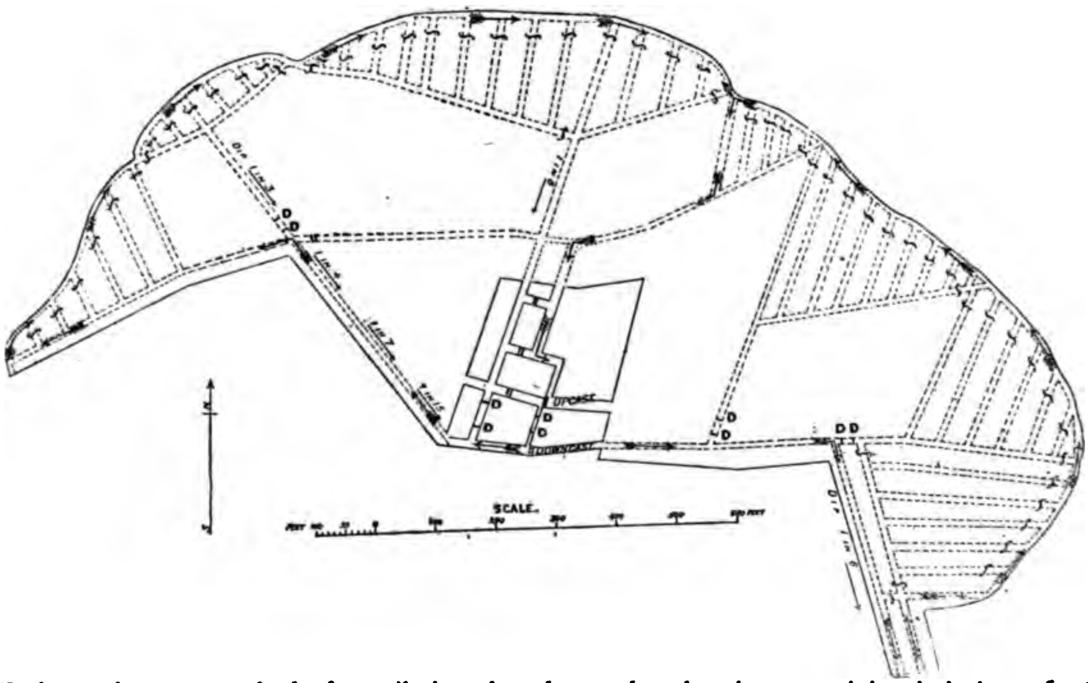
Answer.—In preparing for a thorough inspection of a Lancashire boiler I would have the boiler laid off and allowed to cool gradually and then cleaned out, the flues swept, and remove all non-conducting material from the outside of the boiler, and as much of the brickwork as would allow for an inspection of the boiler externally. I would also remove all valves and stop taps from their seats, so that the mountings and fittings could be properly examined. I would direct my attention more especially to the weakest parts of the boiler, such as the internal tubes, flat ends, and longitudinal seams, and also to those parts which are likely to suffer most from corrosion, namely, the tubes under the fire-bars, the water-level of the boiler, and that part of the outside shell which rests against the brickwork. Instances are recorded where corrosion has reduced the plates over the seating walls to $\frac{1}{32}$ of an inch thick.

J. G. BELL.

CORRESPONDENCE UNAVOIDABLY HELD OVER.

VENTILATION PLAN.

Given in West of Scotland District Examination for First and Second-class Certificates of Competency. 1891.



We have shown a method of ventilating the above plan, but in our opinion it is imperfectly laid out and cannot be ventilated satisfactorily.

Printed and Published by STROWGER AND SON, Clarence Yard, Wallgate, Wigan; also Published by JESSE SALISBURY, 48, Fleet Lane, Farringdon Street, London, E.C., and JOHN HEYWOOD, Manchester.

MINING

A JOURNAL DEVOTED TO THE INTERESTS OF MINING STUDENTS.

[N]o 10. Vol. III. SATURDAY, APRIL 6, 1895. FORTNIGHTLY. ONE PENNY.

CONTENTS.

EASY LESSONS ON
MINE VENTILATION.

By J. CARTER, First-Class Certificated Manager.

(COMMENCED IN No. 9, VOL. III.)

IT will be as well to next explain the construction and the use of the following instruments, viz., anemometer, water-gauge or current-pressure gauge, barometer, and thermometer.* The important part which these instruments occupy in most of our calculations on mine ventilation makes such explanation necessary.

ANEMOMETER.

What is an anemometer and what is its use? Biram's anemometer is the one which is generally used. It consists of a hoop which encloses a wheel carrying vanes and which revolve when exposed to the air-current. Connected therewith are toothed wheels, of varied diameters, fixed on spindles, and to these are attached pointers, which traverse the faces of the dials, thereby recording the velocity of the air. These dials are marked in units, tens, hundreds, and some even more.

Its use is to enable us to measure the velocity of the air, and in order to obtain the number of cubic feet per minute we multiply the velocity per minute recorded by the sectional area of the airway, and the result is cubic feet per minute. Owing to the friction of the anemometer a slight correction ought to be made in very fine calculations, but as this is so small it is not taken into account in ordinary calculations. As different results may be obtained in the same airway, owing to different velocities at different parts of the same airway, the holding of the anemometer is of importance and worthy of remark. It should be held at arm's length in front of the body, keeping the vanes square with the current of air, at the same time moving the anemometer slowly and uniformly over the whole area of the airway. Several trials should be made in the same place and the average result taken.

When great accuracy is required the best method is to fix fine wires or strings across the road from side to side and from floor to roof, at regular distances apart and at right angles to each other, thus dividing the airway into a number of equal divisions, and then note the revolutions of the anemometer, say for 1, 2, 3, or 4 minutes in each division, and take the area of these divisions.

WATER-GAUGE OR CURRENT-PRESSURE GAUGE.

What is the water-gauge and what is its use? It is an instrument of very simple construction and consists of a glass tube, bent like the letter U; both ends of the tube are open. When in use a little water is placed in the bend of the tube and by the aid of a sliding scale, which is attached and marked in inches and decimal parts of an inch, we are enabled to note the difference

* Sketches of these instruments appeared nNo, 2, Vol, III,

in the height of water in the two tubes, and this difference is the water-gauge or pressure exerted to ventilate the mine beyond this point. At the top of one arm is a nose point, which is placed through a door or stopping, so that one end of the tube comes in contact with the intake and the other with the return. As the tube is open at the ends the result is that, owing to a difference of atmospheric or air-current pressure between the intake and return, the water on the intake side is depressed and, of course, causes a corresponding rise on the return side. The force of the ventilating current, whether obtained by furnace or fan, is shown by the use of this instrument.

To find the pressure per square foot multiply 5·2 by the indicated height of water-gauge recorded on the scale in inches. Thus, if the water-gauge indicated ·7, the pressure in lbs. per square foot would equal $\cdot 7 \times 5 \cdot 2 = 3 \cdot 64$ lbs. The weight of a cubic inch of water being ·036 lbs., say water-gauge reads one inch, the pressure is ·036 lbs. per square inch, or $\cdot 036 \times 144 = 5 \cdot 184$ lbs. per square foot.

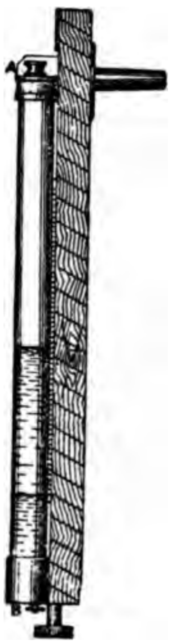


FIG. 1

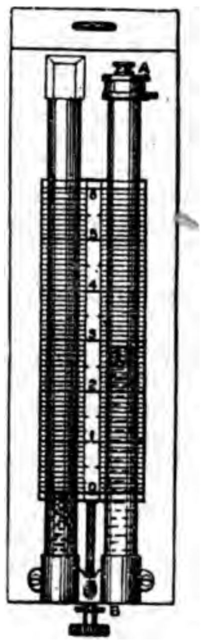


FIG. 2.

By the use of the water-gauge we have a check on our air-courses, because should the airways remain in the same state over several days and the ventilating power unaltered, the water-gauge under ordinary circumstances would remain practically the same, if nc the probability is that some derangement the ventilation has taken place. If the readir is greater than has been usually the case, is apparent that the friction of the air-currei is greater. This may have been caused by heavy fall in one of the main airways, ar steps should at once be taken to remove tl obstruction. If, however, the reading is coi siderably less, the friction of the air-currei must have decreased, and this means th: the air is leaking and is not doing its woi properly. The cause of this may be that tl doors have been left open, or a stopping ‹ air-crossing broken through, thereby reducir the length of the air-current.

BAROMETER: ITS CONSTRUCTION AND USE.

The pressure of the air at any place usually measured by the height of a colum of pure mercury which it will support, ar the instrument used for the purpose of asce taining the pressure is called a barometer.

ITS CONSTRUCTION:—Take a piece of ve clean glass tube, 35 to 36 inches in lengtl 0·75 inch diameter of bore, and closed at oı end. Fill this tube with perfectly pu mercury and boil it in the tube to expel a the air bubbles, which may be found in thin film against the inner surface of tl glass when the mercury is introduced. Whe the tube is filled with mercury place tl thumb over the open end so as to prevei any air entering while the tube is bein inverted, with its open end, in a vessel coı taining mercury. We shall then find c removing the thumb that the mercury sinl five or six inches in the tube when hel upright, and the column of mercury stanc about 30 inches above the surface of th mercury in the vessel. This is the height ‹ the mercury which the ordinary pressure ‹ the atmosphere will balance, but of course varies from 28 to 31. Attached to th barometer is a scale and a sliding vernier fixe to it, by means of which may be read or hundredth part of an inch. If we take wat‹ instead of mercury, we know that the weigl of mercury is 13596 times that of wate therefore the height of the water colum supported by the atmosphere would be:—

$$\frac{13{,}596 \times 30 \text{ inches}}{12} = 34 \text{ feet nearly}$$

This height will balance a column of mercu 30 inches.

A cubic foot of water weighs 62·4 lbs., the pressure per square inch can easily be calculated. A water column, 34 feet high and one square foot in sectional area, supported by the atmosphere, contains 34 cubic feet of water, which weighs $34 \times 62{\cdot}4 = 2121{\cdot}6$ lbs. This force is distributed uniformly over one square foot or 144 square inches. The result is that this column of water exerts a pressure of $\frac{2121{\cdot}6}{144} = 14{\cdot}73$ lbs. per sq. inch.

The barometer is of very great service in showing atmospheric changes, because a depression or lowering of the barometer indicates a lowering of the pressure, and the result is that gases of mines, in goaves, etc., are liberated very freely. Sometimes before a noticeable change in the barometer has taken place we have records of gas having been found in roads previously clear, proving that gas is more sensitive to atmospheric changes than mercury. It also teaches us a lesson, and that is, we must always be on the alert for changes and not trust solely to the barometer for such.

A cubic foot of air near the surface of the earth, at the freezing temperature of water, weighs 0·0807 lbs., so that the ratio of water to that of air per cubic foot is

$$\frac{62{\cdot}4}{{\cdot}0807} = 773$$

That is, air at sea level is about 773 times lighter than water. Hence, if the air were of the same density throughout the atmosphere, as it is near the surface of the earth, the height of the atmosphere (if uniform) would be $773 \times 34 = 26{,}282$ feet, or about five miles.

To find the height of the mercurial column corresponding to the depth of a shaft apply the following rule:—

I = Inches of mercury due to depth of shaft.
D = Depth of shaft in feet.
B = Height of barometer at the pit top.
B at bottom will equal I + B on top.

$$D = \frac{26{,}282 \times I}{B} \quad \text{Rule.}$$

For example take the following:—Shaft, 1,500 feet deep; barometer, 30·5 on surface; temperature, 65° Fah. on surface, and 78° Fah. at pit bottom. What is the difference in the pressure of the air on the surface and the bottom of the shaft and in the barometerical reading?

$$I = \frac{1500 \times 30{\cdot}5}{26{,}282} = 1{\cdot}74$$

Therefore, the reading of the barometer at the pit bottom would equal $30{\cdot}5 + 1{\cdot}74 = 32{\cdot}24$ inches, height of barometer.

The difference in the weight of a cubic foot of air at the top and bottom of the shaft is found as follows:—

$$\frac{1{\cdot}3253 \times 30{\cdot}5}{459 + 65} = {\cdot}07714 \text{ Top of shaft.}$$

$$\frac{1{\cdot}3253 \times 32{\cdot}24}{459 + 78} = {\cdot}07956 \text{ Bot. of shaft.}$$

$\therefore {\cdot}07956 - {\cdot}07714 = {\cdot}00242$ lbs. difference in weight of a cubic foot of air at the bottom and top of the shaft.

(*To be continued.*)

ANSWERS TO CORRESPONDENTS.

JOHN HARRISON (Ashington Colliery, Northumberland).—We are always pleased to hear that our readers, and especially our competitors, have been successful in their examinations, and heartily congratulate you upon having obtained your first-class certificate. We hope you will still continue to compete in our competitions.

R.F.—The sketches should be made in Indian ink and may be any size, as we can have them reduced to suit our pages. Many students spoil otherwise neat sketches by writing across them. If they will simply write the names or description in pencil on the sketch we shall have them inked in correctly. Yes, it is our endeavour to make everything understood by even the most ignorant.

J.T.—You need have no anxiety as to the ventilation plans discontinuing as yet. This original departure has been too well appreciated to be so short lived.

CONSTANT READER.—It is our desire to give our readers, no matter of what station, equal chances of success, and having our attention drawn to the fact that those who had their questions criticised would be cognizant of how their percentage stood with reference to the Gold Medal Competition, we choose to see it in that light and discontinued the criticisms. Our management of this paper for the last eighteen months is a sufficient guarantee to those who have watched its progress during that time that everything is carried on in a just manner, and our recent action with reference to the criticism bears this out. We have no favourites, and a poor reader has our consideration as well as any other. Perhaps you think that this should not be so.

CORRESPONDENCE.

ANSWERS TO STEAM AND THE STEAM ENGINE AND GEOMETRY QUERIES.

SIR,—With reference to A. Hart's first query *re* taking a diagram from an engine and calculating the work done I would advise that he should obtain a

good book on steam and the steam engine, such as Prof. Jamieson's, for it is a difficult matter to answer such a question in terms that will enable other than those who have already a fairly good knowledge of the subject to understand it thoroughly.

In answer to the second query, a radian is the angle which at the centre of a circle stands on an arc, equal in length to the radius of the circle. It will therefore be seen that the radian is a definite angle and is the same no matter what size the circle may be. A radian is 57·2957 degrees. The circumference of a circle is 3·1416 times its diameter, and as the diameter is double the radius the number of radians in a circle will be $3{\cdot}1416 \times 2 = 6{\cdot}2832$. Another method of finding the number of radians in a circle will be to divide 360 by 57·2957.

In answer to the third query, there is no loss of power from the oblique motion of the connecting rod other than that of friction, which it is impossible to prevent.—STUDENT.

VENTILATION PLAN.

Sir,—I have ventilated the accompanying plan, which I offer for your criticism, for which are enclosed six stamps. I have obtained valuable advice from the last one I sent, which will be useful at some future time. Wishing your journal, which is like sixpence against six pennies, small but worth the whole of them, every success.—A.H.M.

COMPETITION QUESTIONS.

No. 13 SET.

TO the sender of the best set of Original Answers in each Stage will be awarded the following:—

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2.—To be written on separate sheets of paper with name attached, and on one side of the paper only. Sketches to be in ink (Indian ink preferred) on *unruled* paper.
3.—Correct name and postal address must be sent.
4.—They must reach us by April 19th, 1895.
5.—The Editor's decision as to winners to be final.

ELEMENTARY.

Question 1.—What are cannel, hard steam coal, and anthracite, and where are they chiefly found in the United Kingdom?

ADVANCED.

Question 2.—What volume of fresh air should be provided per minute for each man, lamp, and horse?

Question 3.—How is the amount of air passing through the workings of a colliery determined?

FIRST-CLASS.

Question 4.—What other precautionary measures besides those already in force do you deem necessary for the prevention of accidents in and about mines, taking into consideration all recent information?

Question 5.—How would you ventilate the bottom of an upcast shaft which is being sunk deeper from one seam already working? Give sketch.

THE ENGINEERING OF COLLIERIES

Being a Treatise on Colliery Machinery, Appliances, and Constructions.

By T. A. O'DONAHUE.

(COMMENCED IN NO. 9, VOL. III.)

WINDING.—CONTINUED.

PULLEYS. In latter years the importance of using large pulleys has been duly recognised, and pulleys of 18 and 20 feet diameter are in common use. The advantages gained by the adoption of such large diameters are:—Friction is reduced and excessive bends in the rope are obviated. For similar reasons the angle which the rope makes when passing over the pulley should not be less than 45 degrees. The general design of winding pulleys is too well understood to necessitate more than a few words. They consist simply of cast-iron boss and rim, with wrought-iron spokes, the whole forming a wheel, which is made as light as considerations of strength will allow, as its duty is to change the direction of the rope, and not to act as a fly-wheel. The groove for a round rope pulley is semicircular at the bottom, but widens out a little towards its outer edge to allow a little play for the rope. This is necessary when winding with round ropes under ordinary conditions, as the rope is constantly changing its position on the drum. For flat ropes the bottom of the pulley groove should be flat, and need only be slightly wider than the rope, as their is no horizontal change in the position of the rope; the successive coils on the reel or drum overlapping each other.

ROPES. The materials of which winding ropes are constructed are hemp, fibre, iron and steel. Of the two first materials we have little to say, for the simple reason that they are utterly unsuitable for shafts of any considerable depth, though still in use at many collieries on the continent. Iron wire ropes have been extensively used for winding purposes, and for a short time were preferred to steel; but this was in the early days of steel ropes when they were only imperfectly constructed, and in many instances worked badly. The improvements which have been made in their manufacture, however, now make them far preferable to iron ropes by reason of their lightness and durability.

The forms of ropes at present in use for winding purposes are round and flat. The days of flat ropes have come, but have almost gone. Not a considerable number of years ago the general opinion was in favour of flat ropes as they were thought to possess several advantages over round ropes; but these advantages, if they ever existed, to an extent which should warrant them having more than a momentary consideration, are considerably outweighed by the inferiority of flat ropes generally. The theoretical advantages of flat ropes are:—(1st) The rope is constantly maintained in a direct line behind the pulleys, thus reducing side friction. (2nd) The tendency of the rope to twist is not so great as in a round rope. (3rd) A partial counterbalance of the load is effected by the coils of rope overlapping each other on the reel or drum, thus increasing or decreasing the working diameter of the drum in an advantageous manner. When the load is at the bottom of the shaft, and is in consequence greatest by reason of the extra length of rope, the drum is at its smallest diameter. At the same time the other drum with its load at the top of the shaft is at its greatest diameter, so that for one stroke of the piston the lighter load will travel a greater distance than the heavier load, and this effects a partial counterbalance. It is apparent that these advantages do exist, but if the engine-house is a reasonable distance from the centre of the pit, the side play of a round rope will not be such as to produce evil effects. The non-twisting element of the flat rope is of absolutely no importance for winding under ordinary circumstances as guides are used, and even with conditions which would advocate the use of a non-twisting rope, the flat rope does not recommend itself so much as the non-twisting round rope, which by a special mode of manufacture possesses the non-twisting property almost equally as well. The most important of the three advantages which it is stated the flat rope possesses is that of effecting a partial counterbalance, but a more perfect counterbalance can be effected by several methods with the round rope. Flat ropes cost considerably more than round ropes, are of far greater weight to support the same strain, and wear only half as long, so that there is little wonder that they are now discountenanced.

The following tables of breaking strains of wire ropes are those published by a leading firm of rope manufacturers:—

ROUND WIRE ROPES.—BREAKING STRAINS.

Circumference. in:	Weight per fathom. lbs.	Best Plough Steel. tons.	Crucible Steel. tons.	Best Bessemer Steel. tons.
1	1 1/8	4 1/2	3 1/2	2
1 1/8	1 1/4	5 3/4	4 1/2	2 3/4
1 1/4	1 3/8	7	5 1/2	3 1/4
1 3/8	1 9/16	8	6 1/2	4
1 1/2	1 3/4	9	7 3/4	4 1/2
1 5/8	2 1/2	11	9	5 1/4
1 3/4	3	13	10	6 1/2
1 7/8	2 1/2	15	12	7 1/4
2	4 1/2	18	14	8 1/2
2 1/8	4 3/4	21	16	10
2 1/4	5 1/4	23	18	11
2 3/8	5 3/4	26	20	12
2 1/2	6 1/2	29	22	13
2 5/8	7 1/4	32	24	14
2 3/4	7 3/4	34	26	16
2 7/8	8 1/4	37	28	17
3	8 3/4	40	31	18
3 1/8	9 3/4	43	33	19
3 1/4	10 1/2	46	35	21
3 3/8	11 1/2	49	38	22
3 1/2	12 1/2	56	43	25
3 5/8	13 1/4	58	45	26
3 3/4	14	62	48	28
3 7/8	15	66	51	30
4	16	71	55	32
4 1/8	17	74	57	34
4 1/4	18	81	63	37
4 3/8	19	84	65	38
4 1/2	20	93	72	42
5 5/8	21	95	73	43
4 3/4	22	97	75	44
4 7/8	23 1/2	102	79	46
5	25	109	84	49
5 1/4	27	123	95	56
5 1/2	29	134	104	61
5 3/4	32	146	113	66
6	36	158	122	72

The above are for ropes of six strands of seven wires each twisted round a hemp core.

FLAT WIRE ROPES.—BREAKING STRAINS.

Size in inches.	Weight per fathom. lbs.	Best Plough Steel. tons.	Crucible Steel. tons.	Best Bessemer Steel. tons.
2 1/4 × 1/2	10	36	27	16
2 1/2 × 1/2	12	42	31	19
2 3/4 × 5/8	14	49	37	22
3 × 5/8	16	58	44	26
3 1/4 × 5/8	18	66	50	30
3 1/2 × 5/8	20	74	55	33
3 3/4 × 11/16	22	79	59	35
4 × 11/16	25	91	68	41
4 1/4 × 3/4	28	100	75	45
4 1/2 × 13/16	31	108	81	49
4 3/4 × 7/8	34	115	86	51
5 × 7/8	36	124	93	56

WIRE CONDUCTORS.—WEIGHTS.

Circumference in inches.	Weight per fathom.	Circumference in inches.	Weight per fathom.
2½	9	3¾	16½
2¾	10½	4	20
3	12	4¼	23
3¼	13½	4½	26
3½	15	4¾	29

The working load for winding should not be more than one-tenth of the breaking strain, and for inclines, and haulage in general, from one-seventh to one-eighth of breaking strain.

As will be seen by the tables there are several qualities of steel, and for winding purposes the best quality should be used. For haulage it may be found economical to employ one of the Bessemer or crucible steel ropes, as they are generally subjected to rough usage, for this kind of work.

If a rope receives proper care it will materially add to the period for which the rope will wear. The principal considerations in the care of wire ropes are:—They should be kept well greased, should not be put on drums of too small a diameter, and after being used on one size of drum they should not be put upon a drum of any other size. If the rope is worked upon a smaller drum it will be more especially injured. In the practical working of collieries we know that ropes are frequently changed from one drum to another from an economical standpoint. This of course is not to be condemned, but as little changing should be done as possible. Large pulleys should be placed at such places where the rope changes its direction, and friction rollers should be fixed at intervals along haulage planes to prevent the rope from dragging along the floor. By far the greatest injury is done to ropes by unnecessary straining or jerking. This is a common occurrence where quick winding is necessary; the cage arrives at the bottom of the shaft with a bang, and immediately the signal is given the engineman puts on full steam, and as there is no doubt several inches of slack rope or chain, the load is taken up by the rope with a jerk. Messrs. Craddock and Co. have made a series of experiments to ascertain the strain upon a winding rope with a few inches of slack chain. In one test the cage and empty tubs weighed 2 ton 17 cwt., when lifted gently the strain as ascertained by a dynamometer was 3 tons, with 3 inches of slack chain the strain was 5 tons, and with 12 inches 7 tons. It will therefore be easily realised that the extra strain put upon winding ropes by jerking up the load must do the rope great injury.

SIMPLE RULES FOR CALCULATIONS.

Students will find a few simple approximate rules for the calculations of the weights and breaking strains of wire ropes of the utmost service:—

ROUND ROPES.

Circumference squared = weight per fathom in lbs.

Lbs. per fathom × 2 = breaking strain in tons for Bessemer steel.

Lbs. per fathom × 3½ = breaking strain in tons for crucible steel.

Lbs. per fathom × 4½ = breaking strain in tons for best plough steel.

FLAT ROPES.

Breadth × thickness × 8 = weight per fathom in lbs.

Lbs. per fathom × ·8 × 2 = breaking strain in tons for Bessemer steel.

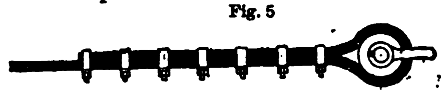
Lbs. per fathom × ·8 × 3½ = breaking strain in tons for crucible steel.

Lbs. per fathom × ·8 × 4½ = breaking strain in tons for best plough steel.

The above rules are only approximately correct, but they can be easily remembered, and will not be found to differ more from the tables given than would tables published by another firm of rope manufacturers.

ROPE ATTACHMENTS. — The connection between the winding rope and the link of the suspension chains is known as capping. Fig. 5 shows the best method of capping flat ropes, the rope being bent back and secured by a series of clamps which effectually prevents the rope from slipping, and does not injure it the same as by the old method of rivetting. This method of capping is also adopted for round ropes. A good form of capping for round ropes is shown by fig. 6. The end of the strands are untwisted for a short distance and are then bent back so as to make the end of the rope conical. A slightly conical capel is now put on and is held secure by collars which are put on hot and driven down tightly on the capel.

Fig. 5



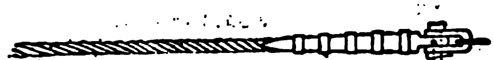


Fig. 6

It has been found that the end near the capping is always the first to give way in a winding rope, and it is considered advisable to cut off a few feet of the rope at this point about every six months and form a new capping. (*To be continued.*)

VENTILATION PLAN.

For Ventilation Plan see inside page of cover.

ANSWERS TO QUESTIONS

No. 10 Set—In No. 7, Vol. III.

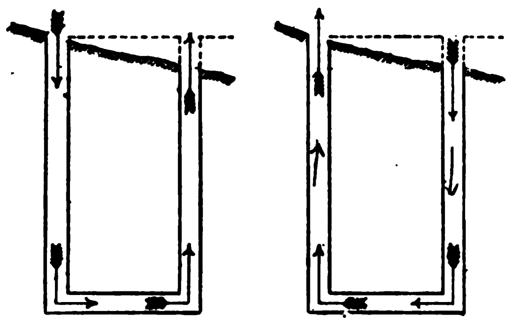
ELEMENTARY.

PRIMITIVE METHODS OF VENTILATION.

Question 1.—Describe with suitable sketches the primitive methods of ventilating mines.

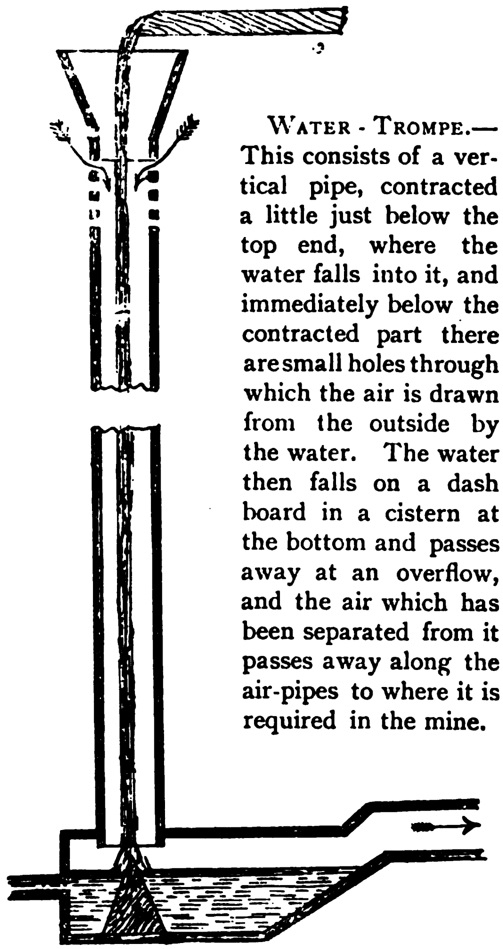
In the early days coal mines were only ventilated by natural ventilation, but after a time, when the shafts became deeper and the workings more extensive, it was necessary to adopt some other means of ventilation. A fire swinging in an iron grate and suspended in the shaft was brought into use to increase the ventilation, but was dispensed with when the furnace came into operation. The steam-jet, water-trompe, and wind-cowl were also brought into action.

Natural Ventilation.—The conditions which cause natural ventilation are as follows: (1) There must be two entrances to the mine. (2) The two entrances must be on different surface levels. (3) The density of the air in the mine must be different from the outside air. When the entrances to the mine are at the same surface level the erection of a tall chimney over one of the them has the effect of producing a difference of surface level. The entrance at the lower surface level is the downcast in winter and the upcast in summer.



Summer Winter
Natural Ventilation

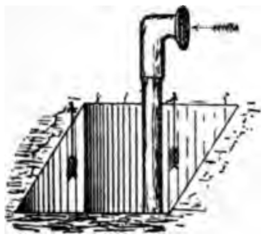
Furnace Ventilation.—Before mechanical ventilation came into use artificial ventilation was produced by furnace. The furnace is placed near the bottom of the upcast shaft and produces ventilation by reducing the density of the return air. It is built in a double-arched drift, made of brick or stone, so as to prevent it from setting fire to the seam. If the excavation is in the solid, stone side walls are sufficient, but if it is in the seam the side coal must be removed to allow an archway on each side of the furnace for the air to pass along and thus prevent the ignition of the coal. When the return air is dangerous it is passed off clear of the fire by means of a dumb-drift. Furnaces are made from 6 to 12 feet wide and from 6 to 20 feet long, the height above the fire-bars is from 4 to 6 feet, and from the fire-bars to the floor about 4 feet. (*See sketch of furnace and dumb-drift, page 99, No. 8, Vol. III.*)



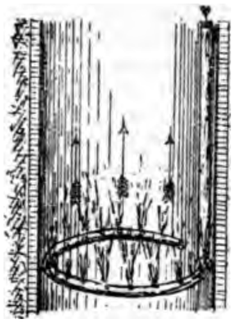
Water Trompe.

Water - Trompe.—This consists of a vertical pipe, contracted a little just below the top end, where the water falls into it, and immediately below the contracted part there are small holes through which the air is drawn from the outside by the water. The water then falls on a dash board in a cistern at the bottom and passes away at an overflow, and the air which has been separated from it passes away along the air-pipes to where it is required in the mine.

Steam-Jet.—This arrangement consists of a pipe from the steam boilers carried down the shaft to a certain depth and connected to another pipe passing around the shaft, on the top of which are a number of small holes through which the steam escapes in small jets. The issue of steam gives the air motion in addition to heating it. The steam-jet is very soon applied and proves useful in case of an emergency when the ordinary ventilation arrangements have been damaged.



Wind Cowl



Steam Jet

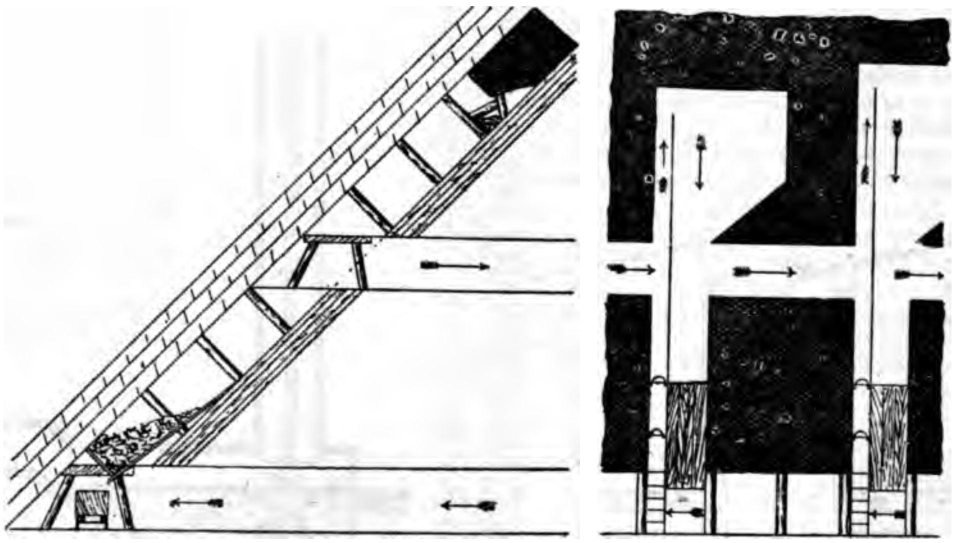
WIND-COWL.—This method is sometime used during the sinking of a shaft and i constructed as follows:—A pipe of thin meta or wood is made about one square foot area or less, to which is fitted a revolving cap head. The lower end of the pipe is carrie down the shaft almost to the bottom, an the open mouth at the top is turned toward the wind. A fresh current of air is thu forced down to the bottom of the shaf where the men are at work, and this displace the foul air, forcing it up the shaft.

THOMAS WEBSTER

ADVANCED.

THE WORKING OF INCLINED SEAMS.

Question 2.—Describe the usual arrangement for bringing coal from the working face to the wagon road in mines of considerable dip, and say what contrivances and precautions should be adopted to ensure the safety of the workmen.



Section Plan
METHOD OF WORKING INCLINED SEAMS

Answer.—In the question, the dip or inclination of the seam is not given, but for the coal to be removed from the face to the wagon road will require a dip of about 30°, 35° or 40° from the horizontal, this being termed a highly inclined seam. In this case one level is about horizontal for a wagon road as shown in sketch, and the method of working is similar to the pillar and stall with a smaller level driven about 30 feet from the main level for the return air also shown in sketch. I was employed in a seam of 35° or 45° from the vertical for fou years in U.S.A., the mine was simple to work and also to ventilate. The banks were started 6 feet wide and driven 30 feet, and then opened out to 18 feet. The props were set in straight rows of five props each; along the face a 2 inch plank was placed behind the props next to the coal face to stop the coal from rolling down the bank, so that the workmen could keep themselves up to the coal face to hole underneath the coal. After the undercutting was done shots were fired and the lumps broken to the size of half a cwt.; the plank that had been placed behind the props was then raised, and the coal and small slack from the undercutting slide to the bottom in a shoot where the wagons are loaded; this is the arrangement of removing

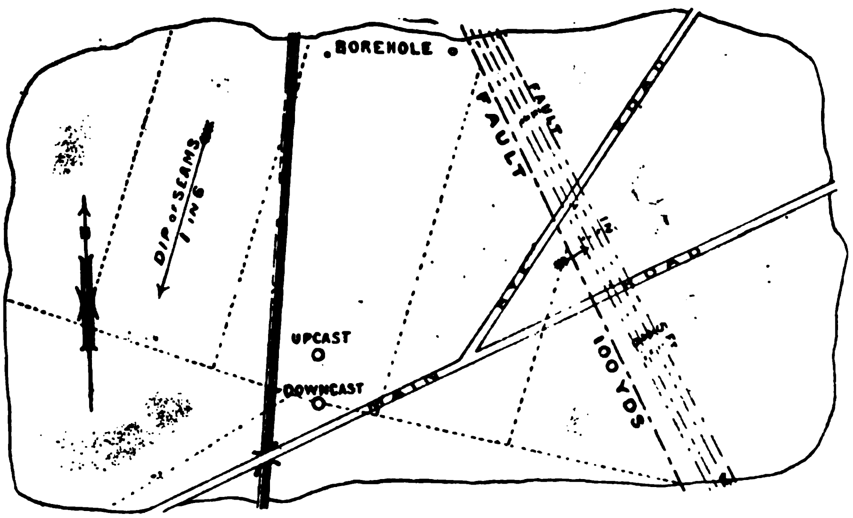
coal from the face to the wagon road. The precautions that are necessary to ensure safety to the workmen are:—Props should be set 4 feet in advance of each other, and on one side inch boards are nailed to the props from the shoot to the face to within about 2 yards, making it as air-tight as possible, and leaving a span on one side of the boards of 4 feet, and on the other side next to the bank 14 feet, this latter one is left open to receive the coal, the other for a manway for the workmen to pass up and down without danger. In seams where rails are laid to the face, coal is removed in tubs running on rails with lockers or sprags put in the wheels to act as a brake or by a jack roller, in which method the tubs are let down with a rope attached behind, and lowered down by a man who winds the rope upon a windlass when drawing up another tub; also by a self-acting incline when the empty tubs are attached to a rope at one end and the full tubs at the other.

HERBERT HALL (RYHILL).

PLAN
OF
PROPOSED COLLIERY

·NOTE—
DEPTHS OF MINES AT BOREHOLE.

6-ft. Mine	(suitable for stoop & room)		50	Yards
4-ft. „	„	longwall	100	„
3-ft. „	„	„	190	„
5-ft. „	„	„	220	„



SCALE—400 YARDS TO AN INCH. Fig. 1.

FIRST-CLASS.

LAYING OUT A PROPOSED COLLIERY.

Question 3.—The above plan shows an estate from under which it is proposed to work the four mines found at the borehole. The mines on both sides of the fault must be got and workings must commence in all the four seams before 15 years. A large output is desired as soon as possible. You are required to give the following information:—

(1) What capital would be necessary to fully equip the colliery before any reinbursement could be expected, and give the principal details of costs.

(2) Best position, number, and depths of shafts. (For calculations the surface may be assumed as level and the strata to give off an ordinary quantity of water).

(3) Show how you would lay out the workings in the 6ft. mine and in one of the others.

(4) Show how you would win the seams on the other side of the fault to which the shafts are situated.

(5) Give the order in which the seams should be worked.

(6) How long would it take to obtain the maximum output and how many tons would be won daily? Give any other particulars or sketches you may deem necessary.

Answer.—Before we can form any idea of the capital necessary for the equipment of a large modern colliery it will be requisite to have some conception of the required plant, etc., as in every instance when the intention is to equip we must have some idea of what we are going to equip. In the case under consideration we have a royalty containing four workable seams, and its extent and situation are shown on the plan given. In the first place, a knowledge of the amount of coal in the royalty will be of importance.

QUANTITY OF COAL TO BE WON.

The size of the royalty determined approximately by the plan is as follows:—

Length of plan from side to side (approx.), $4\frac{1}{4}$ or 4·25 inches. Distance from top to bottom (approx.), $2\frac{3}{8}$ or 2·375 inches. The scale to which the plan is drawn is 400 yards to an inch, hence the determined distance of the royalty will be $400 \times 4{\cdot}25 = 1700$ yards from west to east, that is, supposing the cardinal points to be as per annexed plan; and from north to south the distance will be $400 \times 2{\cdot}375 = 950$ yards. Therefore the quantity of coal may be ascertained as follows:—Area of coal equals $1700 \times 950 = 1{,}615{,}000$ square yards.

Rule—
$$Q = \frac{S\,y\,t}{48}$$

Q = Quantity.
S = Specific gravity
y = Square yards in area
t = Thickness of seam in inches
48 = Constant factor

If the specific gravity of a solid is divided by 48, the quotient is the weight expressed as a fraction of a ton, of a slab of the substance, one yard square in plan, and one inch thick. Hence:—

Seam, 5 feet in thickness:—
$$Q = \frac{1{\cdot}27 \times 1615000 \times 60}{48} \quad 2563812{\cdot}5 \text{ tons}$$

Seam, 3 feet in thickness:—
$$Q = \frac{1{\cdot}27 \times 1615000 \times 36}{48} = 1538287{\cdot}5 \text{ tons}$$

Seam, 4 feet in thickness:—
$$Q = \frac{1{\cdot}27 \times 1615000 \times 48}{48} = 2051050 \text{ tons}$$

Seam, 6 feet in thickness:—
$$Q = \frac{1{\cdot}27 \times 1615000 \times 72}{48} = 3076575 \text{ tons}$$

The total quantity of coal in the four mines or seams will be $2563812{\cdot}5 + 1538287{\cdot}5 + 2051050 + 3076575 = 9229725$ tons.

It is customary to calculate on getting 100 tons per inch per acre. When estimating the quantity of workable coal it is found that one acre, one inch thick, will weigh 120 tons. Hence the percentage of coal likely to be won is 83%, that is, a loss or waste of 17%. But as the loss of coal is determined by the local conditions we can only calculate approximately:—

$$\therefore \frac{9229725 \times 83}{100} = 7660672 \text{ tons}$$

of coal likely to be won and brought to bank.

POSITION, NUMBER, AND DEPTHS OF SHAFTS.

The positions of the shafts are shown by fig. 1, and they are near the main railway, sufficient room for sidings, etc., being provided. It is no doubt a great advantage to have the pits near to the main railway, as it prevents the heavy payment of way-leaves or rights of way, etc.

Two shafts will be sufficient for the proposed colliery, as the royalty is not of a great extent. Both shafts would be used as winding shafts, each shaft winding from two seams—the coals having been transmitted to one level for each respective pit.

The depths of the shafts will be:—Upcast, 164 fathoms; downcast, 172 fathoms. The foregoing are their depths down to the floor or thill of the bottom seam, but it will be necessary to provide sump-room or standage for the water, hence we can take their depths as 166 and 174 fathoms respectively.

NECESSARY APPLIANCES, ETC.

The appliances necessary should be fitted up to cope with at least 1000 tons per day, although it would be wise to have them fitted up for a larger output, because under favourable circumstances this quantity would be exceeded. The colliery, after the sinking operations are finished, will probably wind coal for about fifty or sixty years, supposing that no serious stoppages occur, but the life of a coalfield is rather an uncertain factor to obtain.

Before any reinbursement is obtained it will be requisite to have the colliery fully equipped, so as to cope with the various

exigencies. It is impossible to treat in detail the advantages and disadvantages of the various systems and types of machinery, etc., although this is one of the most important items and one that requires due consideration, if the undertaking must be successful, so for brevity we will only mention them when in course of valuation or calculating the cost.

CAPITAL REQUIRED.

The cost of sinking varies according to the following conditions:—(1) Nature and inclination of strata. (2) Quantity of water. (3) Cost of labour and materials at the time of sinking. Should the strata be very favourable the cost may be as low as that stated in connection with a sinking at Sandwell Park Colliery. The contract price for sinking and walling a shaft, 15 feet diameter, was £8 12s. 6d. per running yard. The company only found engine-power, enginemen, kibbles, lining materials, and the sharpening of tools. But the cost of sinking a shaft can only be determined by gaining a thorough knowledge of the strata to be passed through, the water which is likely to be contended with, and other local conditions.

The following is a list of the principal costs:—

	£
Sinking	15,828
Sinking Engines, Crabs, &c.	2,000
Winding Engines, one for each pit, including erection of engine-houses	5,500
Malleable Iron Pulley Frames	2,000
Heapsteads	4,000
Double-deck Cages (steel) & fittings.	260
Chimney	300
Hauling Engines	2,000
Pulleys	200
Pumping Engine	1,700
Tubs or Trams	1,000
Ropes (plough steel)	300
Guides	1,512
Fan with duplicate engines	2,200
Weighing Machines and Houses ...	300
Nine Lancashire High Pressure Boilers including erection	3,600
Railway Sidings, Loco., and Wagons	8,000
Total	£50,700

The foregoing is a list of the most heavy expenses likely to be incurred by the equipment of a colliery as per plan, but it is impossible to give the prices and description of the various appliances requisite. It will be noticed that many items are not recorded, yet to open out and equip a colliery like the one under consideration a capital of £60,000 would be necessary.

METHODS OF WORKING THE SEAMS.

The workings in the 6 feet mine would be arranged or laid out as shown by fig. 4. After driving out the main headings the coal is formed into rectangular blocks by driving walls and bords into the solid. The walls vary from two yards in width and are generally driven parallel to the cleat or right angles to the bord, but the direction of the dip usually determines the course of the walls or headways. The bords or stalls are driven at right angles to the cleat. They vary in width, but generally are 4 or 5 yards wide. The blocks or pillars left must be of sufficient size to prevent any risk of creep. The workings are arranged into panels or districts by leaving a barrier of solid coal between each district as shown on the plan, fig. 4. When the whole working has advanced a sufficient distance the broken working is commenced. Following up the whole working with the broken working has many advantages:—(1) Increased percentage of round or large coal. (2) Less dead work. (3) Larger amount of coal won. (4) Increased safety.

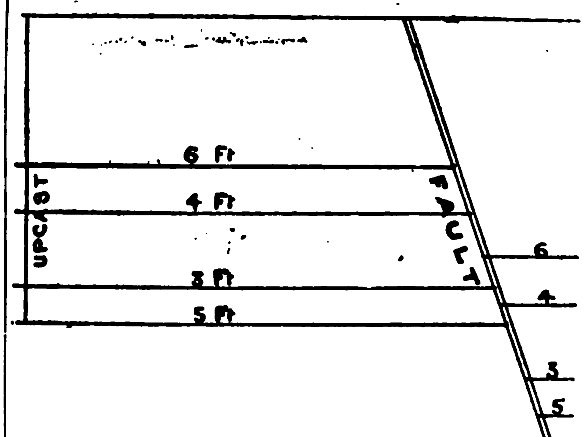


FIG. 2. Section along level direction from upcast shaft. Horizontal scale 400 yards, vertical 200 yards to an inch.

The longwall method, adopted for one of the other seams, is shown by fig. 3. Stall roads are opened out from the main headings and are cut off by levels driven out of the centre or mother-gateway. The centre gateway will be used as a self-acting jig or incline, down which the coals from the various levels are transmitted. The dotted lines in sketch show the old abandoned stalls, which have been cut off by the levels or cross-gates driven out of the centre stall or gateway. The gateways or stalls vary from

20 yards apart, and the levels or cross-gates are commenced every 70 or 80 yards from the mother-gateway. Other items, such as line of face, etc., can only be determined by a knowledge of the surrounding strata.

ORDER IN WHICH THE SEAMS SHOULD BE WORKED.

The order in which the seams should be worked, that is regarding each other, will be to have the top seams kept in advance of the lower ones; the reason for so doing is to prevent the injurious effect which would occur to the upper seams if the lower ones were worked in advance or worked back before those above. When the lower seams are in advance of the upper it causes the strata to subside or sink and causes a great disadvantage to the efficient working of the upper seams. The coal from the upper seams could be brought to the lower seams for the purpose of hanging on at each pit by means of rise-drifts or drop-staples, but this important item would be determined only by the due consideration of the existing circumstances.

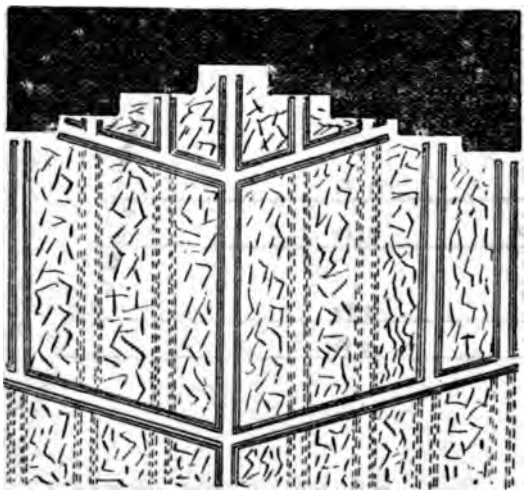


FIG. 3. Method of working by longwall.
Whether the face was straight or as shown would depend upon the nature of the mine.

METHOD OF WINNING.

To determine the method of winning the seams dislocated by the fault it will be necessary to make a section of the strata as shown by fig. 2. The coal from the 6 feet mine would be lowered to the 4 feet mine and both raised from this level up one shaft. The coal from the 3 feet mine and the 5 feet mine would be wound from one landing in a similar manner up the other shaft, and the whole of the mines on the other side of the fault would also be raised from this landing.

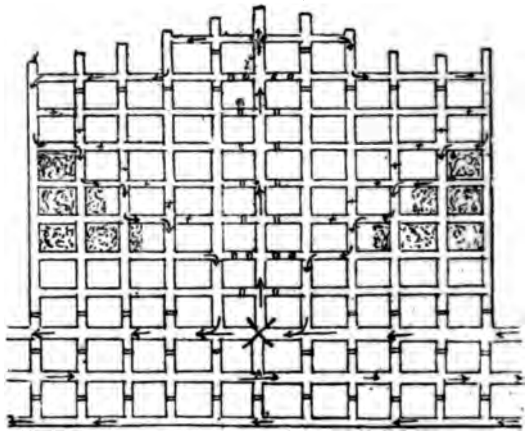


FIG. 4. Method of working 6 feet mine.

PERIOD REQUIRED TO OBTAIN THE MAXIMUM OUTPUT. NUMBER OF TONS DAILY.

The time it would take to obtain the maximum output is a question which is rather difficult to answer, for it frequently occurs that many unthought-of emergencies take place over which there is no control, so that the time calculated can only be deemed approximate. There would be a large amount of work and, therefore, much time would be occupied in opening out the different seams owing to the necessity of driving drifts, etc. In four years the colliery ought to be in fair working order, but the maximum output, perhaps, would not be reached until the mine had been in operation for about 12 or 14 years, or if conditions were unfavourable a longer period would be required.

The quantity of tons daily would begin low, increasing as the seams were opened out and diminishing as the seams reached smaller boundaries. The output would be 100 to 200 tons per day on opening out, and after the various operations had been effected the output would be 1000 tons per day, but this would be exceeded at certain times.

OTHER PARTICULARS.

Should the mine produce much water the sump should be much deeper than beforementioned. The depth given would only be adequate for a very small feeder of water, so that it would be well to have the sump five or six fathoms in depth, as adequate standage is a very common sense item. The answer given may be taken only as a superficial one, because there are depths of information which have not been fathomed. MYLES BROWN.

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MINING

A JOURNAL DEVOTED TO THE INTERESTS OF MINING STUDENTS.

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CONTENTS.

EASY LESSONS ON MINE VENTILATION.

By J. CARTER, First-Class Certificated Manager.

(COMMENCED IN No. 9, VOL. III.)

THE THERMOMETER AND ITS USE.

THE thermometer may be called a measurer of heat or temperature, and for ordinary temperatures liquid mercury is used in its construction. Its action is dependent on the fact that all bodies expand and contract with a rise and fall of the temperature. A thermometer consists of a glass tube closed at the top, with a bulb at the bottom, and containing a quantity of mercury. Attached to it is a scale of degrees, graduated according to either of the following: Fahrenheit, commonly used in England; Centigrade, which is generally applied to scientific calculations; and Réaumur, which is chiefly used on the continent.*

The thermometer as used in mines registers the temperature of the air, so that we are able to measure the difference of the temperature of the air in the downcast and upcast shafts or at any point in the workings of the mine.

We will now consider the practical use of the various instruments described, and by the following examples I will endeavour to make it sufficiently clear to those students who have no practical knowledge of such instruments, to enable them to understand their use.

THE USE OF THE ANEMOMETER.

Before the anemometer is of any available use to the student he must be able to calculate the area of the roadways in a mine. For this purpose I will give three examples.

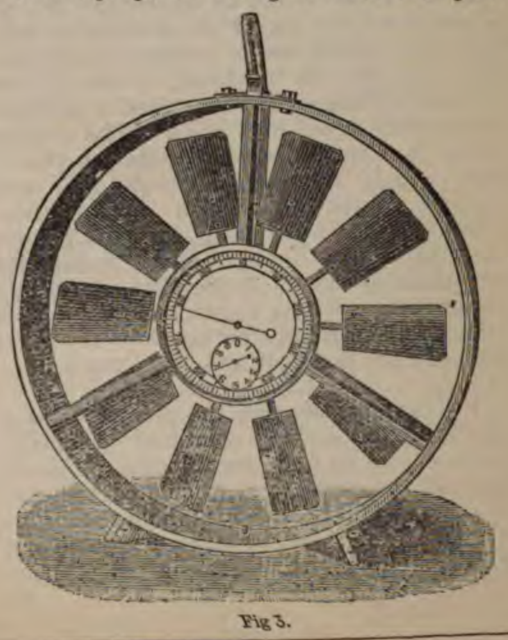


Fig 3.

*For more detailed account of thermometor and comparison of scales see No. 19, Vol. 1.

1st.—Take an airway 10 feet wide by 10 feet high and find its area? The rule is to multiply the width by the height, and the product is the area:—

$\therefore$ 10 × 10 = 100 square feet area.

2nd.—An airway, 10 feet wide, sides 5 feet high, and over this a semicircular arch. Find area. (See fig. 4.) Take the lower portion A first, and find its area, which = 10 × 5 = 50. As the other portion B forms a half circle we can obtain the area in the following manner: Square the height and divide by 2 and multiply by 3·1416. As the circle would be 10 feet, the radius is half of this—5, which is the height of the arch from spring of arch to the top. Thus the area of this part = $\frac{5 \times 5}{2}$ = 12·5 × 3·1416 = 39·27 area of B.

$\therefore$ 50 + 39·27 = 89·27 square feet = total area.

3rd.—A circular shaft is 15 feet diameter, what is its area? Rule, square the diameter and multiply by ·7854 and the product is the area (squaring the diameter means multiplying the diameter by itself):—

$\therefore$ 15 × 15 = 225 × ·7854 = 176·715 sq. ft. area.

In order to find the quantity of air in cubic feet per minute passing through the above airways by the use of the anemometer we must multiply the velocity in feet per minute by the area, and the result is the quantity passing.

To make the reading clearer to our young students I have given an illustration (fig. 3), which shows the face of an anemometer with two index circles, one is marked in units and tens, the other in hundreds. From this we see that the larger circle is marked in tens and sub-divided again into units. The smaller circle is marked in hundreds, so that 1 here equals 100 and 2 equals 200, and so on up to 10, which equals 1000. This shows very clearly that the pointer of No. 1 dial moves once round for one division of No. 2, therefore, in reading the anemometer you must notice the figures on each dial carefully, noting that No. 2 dial indicates the hundreds and No. 1 the units.

For example, suppose the pointer on each dial is at the starting point and we want to make a trial to find the velocity. Having selected the place (and calculated the area of such, to find the quantity) hold the instrument in front of you at arms length in one hand and have your watch in the other, so as to be ready to start when your watch is on the minute. If at the end of a minute the pointer on No. 1 dial (which is marked in tens) stands at 20, and the pointer on No. 2 dial has passed 4, which equals 400, then the velocity of air equals 400 + 20 = 420 feet per minute.

Suppose you commence to find the velocity when the pointers stand as above, viz., No. 1 pointer stands at 20 and No. 2 pointer passed 4, mark these in your note book, and at the end of the minute you must subtract from the numbers indicated (second reading) those of the first reading.

Say at the end of the next minute, No. 1 dial pointer stood at 40, and No. 2 dial pointer had passed 8, which equals 800, the velocity would equal (800 + 40) — 420 = 840 — 420 = 420 feet per minute. With a velocity of 420 feet per minute, find quantity in cubic feet per minute in the foregoing examples:—

1st.—Airway, 10 feet wide by 10 feet high, find quantity:—

10 × 10 = 100 × 420 = 42000 cu. ft. per min.

2nd.—Airway, 10 feet wide by 5 feet high to spring of arch, and over this is a semicircular arch, whose height is 5 feet.

Total area = 50 + 39·27 = 89·27

Quan. of air per min. = 89·27 × 420 = 37493·4.

3rd.—Airway, circular shaft, 15 feet dia.,

$\therefore$ area = 15 × 15 = 225 × ·7854 = 176·715 sq. ft.

Quan. of air per min. = 176·715 × 420 = 74220·3

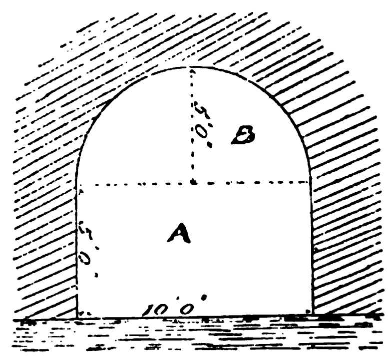


Fig. 4

(To be continued.)

THE ENGINEERING OF COLLIERIES

Being a Treatise on Colliery Machinery, Appliances, and Constructions.

By T. A. O'DONAHUE.

(Commenced in No. 9, Vol. III.)

WINDING.—CONTINUED.

CAGES. The cages used for winding coal are constructed with one, two or three decks as may be required, each deck carrying one or more tubs. The most common arrangement is to have double-decked cages, each deck carrying two tubs, end to end, but in shafts of large diameter each deck may carry three tubs. After the arrangement of decks and number of tubs on each deck have been decided, the dimensions of the cage will depend upon the size of the tubs to be used. The weight of the cage will depend upon the load, and for a steel cage may be taken as a little more than one-half its load of full tubs. They may be constructed of iron or steel, but the latter is the material now generally used, as the weight to be raised is then reduced to a minimum, the steel cage being considerably less in weight than an iron one of sufficient strength

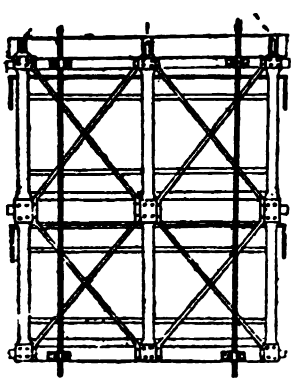


Fig 7

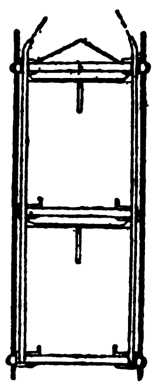


Fig. 8

to carry the same load. The cages are provided with guide checks for square or loops for wire rope conductors, and are fitted with rails and catch bars for the tubs. The upper deck is covered by a bonnet or protecting plate, and is usually made higher than the lower ones so as to accommodate the men; the extra height is also found convenient for lowering the timber props, and in some cases the pit ponies. The construction of the cage will be clearly seen from figs. 7 and 8. The horizontal frames consist of angle steel strengthened by deep flat strips along each side, and these are connected by uprights bound together by diagonal bars. The cage is attached to the rope by six chains, a chain being connected to each of the uprights. These bridle chains should be carefully selected, and should be annealed every few months, as the shocks to which they are subjected tend to give the iron a crystalline nature like cast iron.

CONDUCTORS OR GUIDES.—The cages are prevented from colliding in the shaft by means of guides or conductors. The guides may be rigid of wood or iron, or flexible of wire rope. Flexible guides are much better

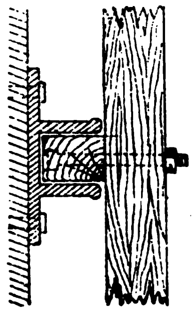


Fig 9

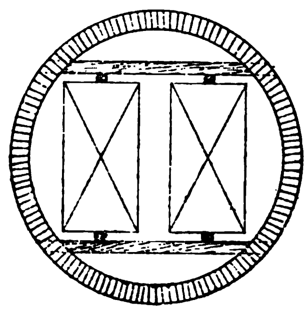


Fig 10

than rigid ones where the circumstances will admit of their adoption. If there is very little clearance space for the cages by reason of pumps or steam pipes being also placed in the shaft, rigid guides must necessarily be used, as it is impossible to prevent a little oscillation with flexible guides. Wood guides are usually made of pitch-pine of about 4 inches square in section, and are secured in long lengths to horsetrees placed at intervals down the shaft, by countersunk screws or bolts (fig. 9). The guide is enclosed on three sides by the shoes connected to the cage, and

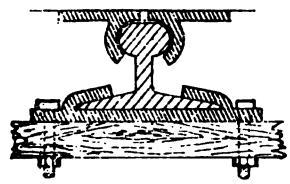


Fig 11

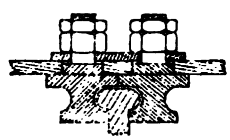


Fig 12

two guides to each cage are usually found sufficient (fig. 10). Timber guides are altogether unsuited to quick winding, and they are ever in want of repairs. They are now seldom used. Where rigid guides are a necessity the best to adopt are the rail guides. The rails used for conductors are very similar to the ordinary flat bottom T rails. They are secured in the shaft by means of special

shaped chairs (fig. 11), which are bolted to horsetrees; and the shoes which are connected to the cage are shaped so as to enclose the greater part of the head of the rail. In order to avoid excessive friction between the shoes and the guides, two small wheels have been substituted for the ordinary shoes (fig. 12). The wheels are so constructed that they enclose the head of the rail on each side. The wheels revolve while passing up and down the guide rails and thus considerably decrease the resistance. The rails commonly used for guides weigh from 50 to 60 lbs. per yard. The only advantage which rigid rods possess is that the cages can be run in less space than with flexible guides, but they possess several disadvantages. They are difficult to fix in a truly vertical position, and when once fixed they are difficult to maintain in their correct position. There is a large amount of friction which makes them unsuited to quick winding, and the horsetrees which are required to connect the guides weaken the shaft and are of great inconvenience. Cast-iron boxes are in some cases however placed in the walling of the shaft for the reception of the horsetrees, so that the sides will not be weakened.

(*To be continued.*)

AWARDS

FOR ANSWERS TO COMPETITION QUESTIONS—No. 10.
(Held over from last issue.)

ELEMENTARY—T. Webster, 7, Birchley Road, Billinge.
Commended—J. H. Senior, F. Cherry, J. Wheatcroft.

ADVANCED—H. Hall, 15, Yardley Terrace, Ryhill.
Commended—W. P. Lawes, J. Stephenson, J. Crone, D. Humphreys, T. E. Aitchison.

FIRST-CLASS—M. Brown, Butterknowle, Darlington.
Commended—Geo. Daykin, J. Harrison, J. G. Bell, J. Davies.

FOR ANSWERS TO COMPETITION QUESTIONS—No. 11.

ELEMENTARY—T. Webster, 7, Birchley Road, Billinge.
Commended—F. Cherry.

ADVANCED—J. Peterkin, Swinley Road, Wigan.
Commended—H. Hall, J. Crone, W. Vickers, and J. Stephenson.

FIRST-CLASS—William Slocombe, 11, Thorne Avenue, Newbridge, *via* Newport, Mon.
Commended—Myles Brown, T. Wallett, J. Davies, J. Scott, J. Jackson, A. J. Gilmore, S. Thorpe, G. A. Hawes, G. Daykin, J. G. Bell, S. Davies, R. Landlep, R. Anderson, Junr.

DAMPING DUST IN MINES.

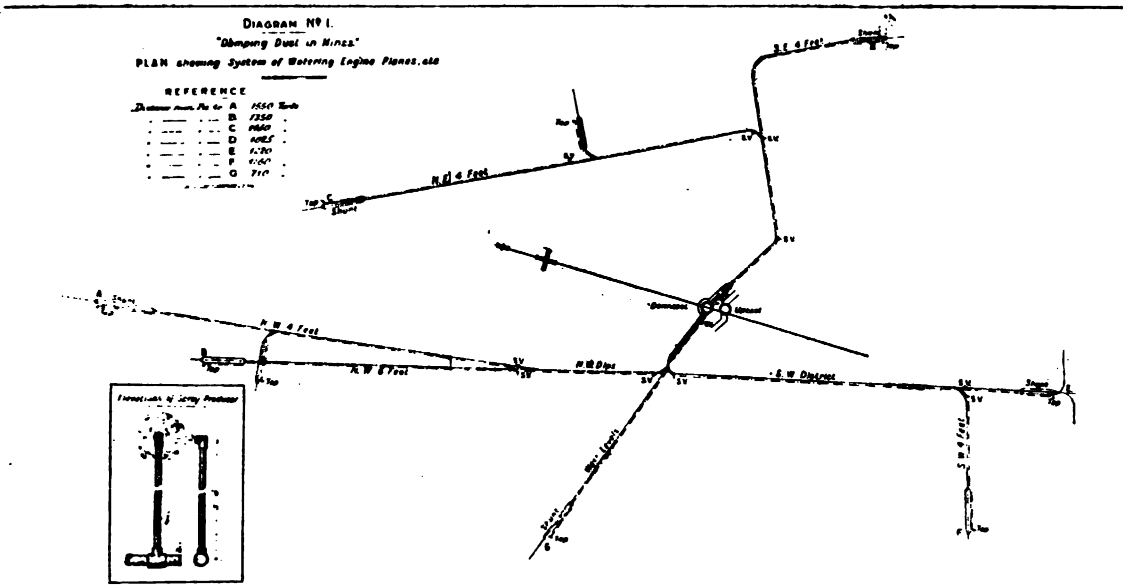
BY MR. H. D. F. MATHEWS, ONE OF HER MAJESTY'S INSPECTORS OF MINES.

Read before the Manchester Geological Society, Jan. 11th, 1895, and reproduced by special permission.

THE Royal Commissioners appointed in 1891 to inquire into the effect of coal dust in originating or extending explosions in mines, whether by itself or in conjunction with fire-damp, and also to inquire whether there are any practicable means of preventing or mitigating any dangers that may arise from the presence of coal dust in mines, in their last report, dated June 13th, 1894, say: While recommending that every effort should be made to prevent undue accumulations of dust, it appears to your Majesty's Commissioners that the only effectual way of dealing with this source of danger would be a satisfactory system of watering, and thoroughly wetting it. We also recommend: 1st. That the firing of shots should be carried out between the shifts and when the majority of the men are out of the mine. 2nd. Where general watering is not prescribed by the inspector, that the roads on either side of the place where a shot is fired should be thoroughly wetted for a space of at least 30 yards; and lastly, that large accumulations of dust, whether on the roof or floor, should not be allowed to remain.

The information placed before us in the Royal Commissioners Report, and the reports of inquiry with reference to explosions in mines, and the personal observations of many of our members, should be sufficient to convince us one and all of the dangerous character of coal dust in mines under certain conditions and considerations. Suffice it to say that coal dust is dangerous in its dry condition, and that if it be damped no danger from it under any circumstances is likely to be met with in colliery operations.

The ventilating currents in travelling around the workings of collieries, have their capacity for moisture increased, or in other words, get thirsty; and to fill up this increased capacity for moisture, or to quench their thirst, they absorb moisture from everything with which they come in contact. Hence the necessity for replenishing them with a fresh supply, as their capacity for it is increased.



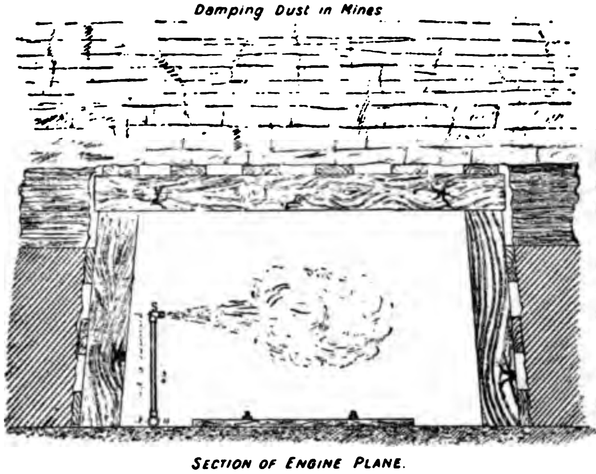
REFERENCE.

Stop Valves shown :— S.V.
Pipes shown thus :— — - — - — -
Pipe from Mouthing to Pit Bottom, 4in., Wrought-iron.
All other Pipes except Standards, $1\frac{1}{2}$in., Wrought-iron.
Standards and Jets, ¾in. *do.*
Average Distance between Jets, 60 yards.

For counteracting this drying power and damping the dust, the following are the most popular, if not the only means, that have been adopted, viz., the application of salt, steam, and water. The effectiveness of salt being very limited it cannot in the extreme cases of steam coal collieries be of but very little service. The application of steam has also been found to work well only within certain limits. The application of water seems to be the most rational means for adoption. Although many ingenious contrivances have been suggested, and are in operation for watering the roadways by tanks or casks, they all have one defect, viz., they give water intermittently, while the demand is constant. However, in bye-roads, where the ventilating current is feeble, they will be of great service. The two methods which seem to be the most perfect for damping the roadways at present are, (1) the spray system of water alone; (2) the spray system in conjunction with compressed air.

(1) "The spray system of water." In some mines perfect saturation of the atmosphere is obtained in which the mere pressure of the water is sufficient to produce a spray. Among other mines, this system is in operation at one of the steam coal collieries which the writer has been connected with, where the roads at present are watered to the extent of 5,960 yards, with sprays every 40 to 60 yards apart. The cistern is fixed in a landing in one of the upper seams, as shown in diagram No. 2. The pipe taking the water down the shaft *from the cistern* to the pit bottom is four inches diameter; and the distance being 480 feet, gives a pressure of 208 lbs. per square inch. The pipes branching east and west at the bottom of the pit are $1\frac{1}{2}$ inches diameter, and are laid along the side of the roadways, as shown on diagram No. 1. The main roads near the pit bottom being rather wide, the hose was used occasionally for that part; and about 100 yards from the pit bottom the spray system commenced. A stand pipe of ¾ inch bore, every 40 to 60 yards, is attached to the main water pipe by a reduced T coupling. The stand pipe is erected vertically from the main water pipe, about three feet in length; and a small angular pipe is fixed at the top of the stand pipe, as shown on diagram No. 1A, in the mouth of which a little lead is melted for nearly an inch distance, and a small hole made through the lead by driving a fine steel drift through it. When the spray is started, if it is found too coarse, by simply tapping the face of the lead with a hammer with an egg-end face the spray can be made as fine as required, and damps the roadway, the distance varying according to the velocity of the air current passing; so that the higher the velocity the further as a rule the spray would be carried; the mist produced being so fine that it could be distinctly seen with an ordinary lamp carried along in the air for a considerable distance before it reached the ground. The mist has done no harm of any consequence to the sides, roof, or floor of the collieries where the writer has seen the spray system in operation, but has the effect of

DIAGRAM No 1A
Damping Dust in Mines



SECTION OF ENGINE PLANE.

cooling the air. In one colliery the average temperature was reduced four to five degrees on the introduction of water for damping the roadways. In some collieries lead plugs are screwed into the stand pipes instead of melting the lead, as are also many other patent sprays in the market. The sprays are 40 to 60 yards distance between each other to the far end shunts, where a tap is fixed, as shown on diagram No. 1, from which water may be taken to the bye-roads in casks or tanks when required, and is also obtainable for horses or ponies working in the district. The waterman, as he is called, is able to attend to the whole length of pipes, and to turn on water to each district, and stop it when required at the junction of the pipes, marked S.V. on diagram No. 1.

No. 2. The spray system in conjunction with compressed air is what may be termed an improved modification of the pipe system.

This system has in addition to the water pipe another pipe for carrying compressed air, which is mixed with the water, and forms a spray, finer perhaps than can be made with water alone, certainly so when the pressure of water is low. And where compressed air is convenient and a high pressure of water not attainable this has a considerable advantage over the system of water only. Indeed it is only necessary for the water to have sufficient pressure, when throttled down, to find its way into the chamber where the compressed air meets it and drives it out.

Mr. H. W. Martin, the general manager of the Dowlais Collieries, Glamorgan, and the mechanical engineer, Mr. Turnbull, brought out a patent of the most perfect system the writer is acquainted with; producing "spray" or "mist" of exceeding fineness with water in conjunction with compressed air.

The spray or mist produced can be made so fine that it is carried by the ventilating current to the roof, sides, and floor, and so damps the finest dust lurking behind timbers, and indeed all parts of the roads which the current touches.

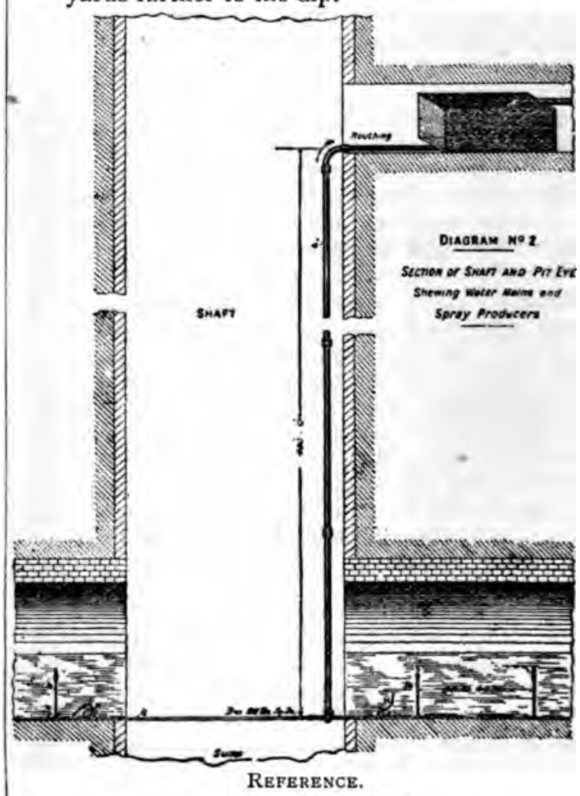
The cooling influence of the sprays when working is quickly detected. The distance to which the moisture is carried varies with the velocity of the ventilating current.

At one of the collieries where this system is in use, the pressure of the compressed air and water are:—

Compressed air.	45 lbs. per sq. inch.
Water	90 lbs. per sq. inch.

The water is throttled to suit the spray.

The compressed air is taken from one of the mains for supplying a pump, and small hauling engine, which were working 1,000 yards further to the dip.



REFERENCE.

S = *Spray Producer.*
H = *Hose Pipe.*
Pipe from Mouthing, 4in. dia., Wrought-iron.
All others except Standards, 1½in. do.
Standards and Jets, ¾in. do.

The water was brought from a cistern fixed in the pit shaft, similar to the previous method described.

The object of having the water as already stated at a pressure of 90 lbs. per square inch, to meet the pressure of compressed air at 45 lbs. per square inch, is to enable the damping to be continued by water alone should any accident occur to the air-compressing machinery or pipes, and the supply of air have to be stopped for a time.

The diagram No. 3 fully explains the arrangement of pipes and other apparatus for applying and regulating the compressed air and water.

A shows a pipe conveying compressed air, alongside which a pipe B is laid for water.

On each of the pipes A and B, in a vertical

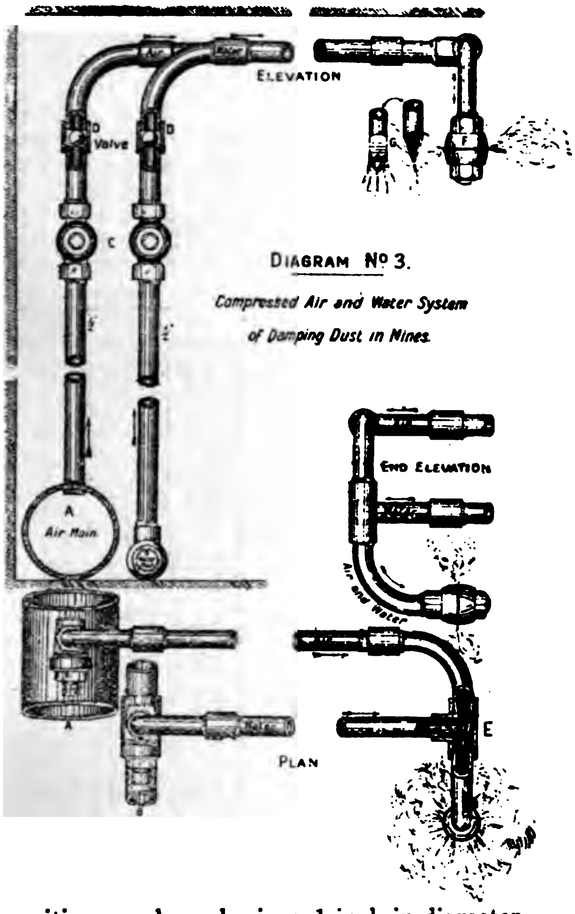


DIAGRAM No 3.

Compressed Air and Water System of Damping Dust in Mines.

position, are branch pipes ½-inch in diameter inside and each has a regulating cock C.

These pipes leading upwards to the roof are carried across to the centre of the roadway.

The compressed air-pipe is connected to the water-pipe by a nozzle in the interior of an ordinary T coupling at E, which forms the junction of the air and water, the water being forced out by the air through the adjustable spray producer F, which is regulated underneath by a nut and screw.

In case of using dirty water, if the spray-producer becomes choked, it can be "flushed" in an instant and set to work again.

To prevent the water passing into the air-pipes should the air be stopped, a small spherical valve D is placed in the ½-inch air-pipe, resting on a leather cushion.

In like manner a spherical ball D may also be placed in the ½-inch water-pipe to prevent air escaping should any accident happen to the water main.

The method of starting the apparatus assuming the pipe A to be filled with air, and B with water, is first to open full the cock C on the air-pipe, then screw the spray-producer with the nut underneath until a fine stream of air passes through the joint; afterwards slowly open the cock C on the water-pipe until sufficient water is forced through the joint to produce the spray required.

When the water is fairly clean an excellent mist or spray can be produced by a spray-producer made by simply flattening the end of a pipe, as shown at G on the diagram. The work is very effectually done, and the trouble and expense caused by the upheaval of the floor by the old style of watering with tanks or hose pipes is avoided. The quantity of water used per spray, when in full work, is about three gallons per hour.

EDITORIAL NOTES.

HOW TO PATENT AN INVENTION.

Unfortunately the Patent Office of this country does not search the records to see whether an intended patent is an infringement upon any previous patent, and the fact that an invention is patented does not make the patentee unliable for infringement. It is, therefore, essential that investigations be first made to satisfy the inventor as to the validity of his proposed patent. In some instances it is well to instruct the patent agents to search the records, but the inventor must use his own judgment on this. If the inventor is now certain that his invention will be a success he may have it patented at once, and this will cost about 12 guineas. If, however, he wishes to make further inquiries as to the probability of its success by reason of its cost or utility, he may have it protected provisionally for a period of nine months at a charge of from 3 to 4 guineas, and if it is decided to patent it afterwards, a further charge of about 10 guineas will be made. We would advise that the patenting be put into the hands of patent agents, and as we have recently had some business in this line ourselves we can strongly recommend Messrs. W. P. Thompson & Co., Patent Agents, 6, Bank Street, Manchester. We will have great pleasure in advising any of our readers as to the probability of success of any invention if we are furnished with the particulars and will guarantee the strictest secrecy.

VENTILATION PLAN.

Given at the Manchester Examination for First-Class Certificates of Competency.—1894.

The accompanying figures show two correct methods of ventilating the Plan.

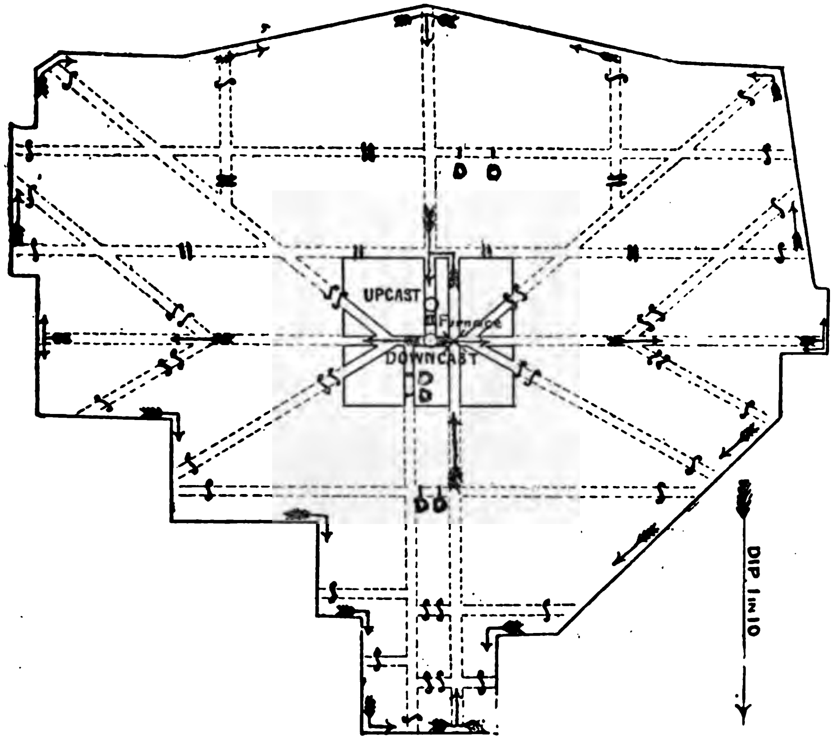


Fig. 1

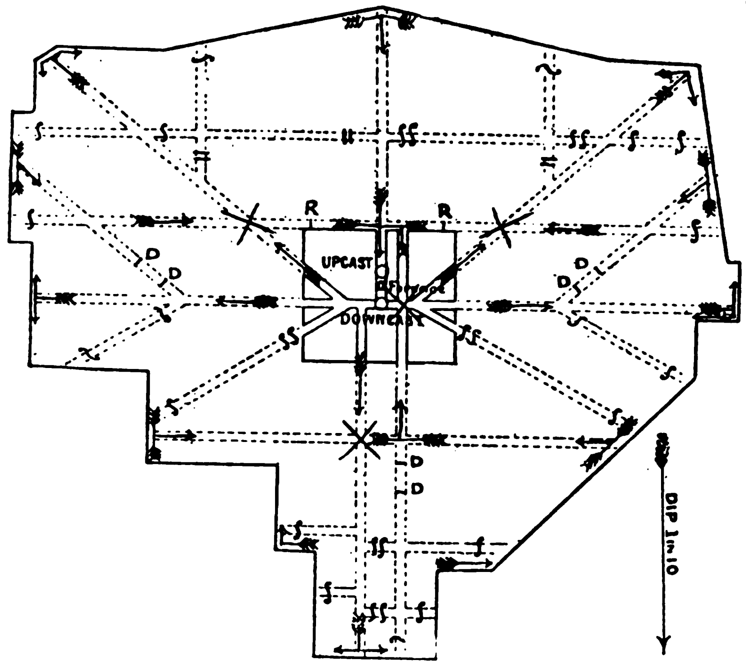


Fig. 2

In figure 1 it will seen that there are two main splits, each of which are again divided into two sub or secondary splits at the face. Four splits are thus formed which are practically of the same length and which would constitute an efficient method of ventilating the workings. There is but one air-crossing, and the principal defect of the arrangement is not essentially one of ventilation but of haulage. The two main haulage levels are unobstructed, but the main downbrow and the two main upbrows, or slants, are closed by sheets or doors. In the downbrow we have inserted doors, but if the exigencies of the case required it they might be replaced by three or four hanging sheets, which would no doubt be sufficient, as in the main upbrows.

In figure 2 we have arranged five main splits, each of which forms two secondary splits. The advantages accruing from such an arrangement are: All the principal haulage roads are unobstructed, and in addition to this, the whole of the goaf is kept ventilated and large accumulations of gas are prevented. The objections to this method are the increased number of air-crossings and the probable necessity of two regulators. To some readers there may appear to be too many splits for the workings given, but they must understand that each road shown on the plan does not simply represent one working place, as it is apparent there is a very considerable distance between some of the roads shown, and that the mine is only opening out.

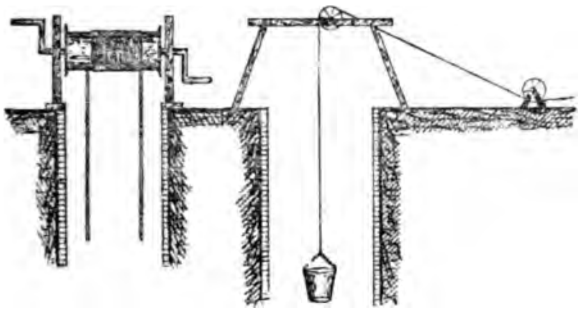
ANSWERS TO QUESTIONS.

No. 11 Set—In No. 8, Vol. III.

ELEMENTARY.

PRIMITIVE METHODS OF WINDING.

Question 1.—Describe briefly with sketches the primitive methods of winding.



Windlass **Derrick**

Answer.—When coal mining was in its infancy, the method of winding the coal to the surface was both slow and dangerous. The coal was conveyed to the surface by means of ladders which were fixed in the shaft. The coal being placed in baskets, which were carried on the heads of the persons engaged, and as the shafts became deeper better methods of conveying the coal to the surface came into use, namely, the Windlass, Derrick, and Horse-gin.

THE WINDLASS.—It consists of two upright pieces of wood which are jointed and made secure to two beams stretching across the top of the shaft. The uprights are steadied and strengthened by stays which are fixed on either side of the uprights. In the upper end of each upright a slot about 10 inches long and 1½ inches wide is cut, and the bottom lined with iron to receive the handles and keep the wood from splitting. The barrel upon which the rope is wound is of wood, hooped with iron at the ends, to prevent it from splitting when the iron handles are driven in. The handles are made of 1 inch round iron, bent twice at right angles, and squared at one end for driving into the barrel. A rope is attached to the barrel, and to the end of the rope a tub or basket is fastened for hauling up the material.

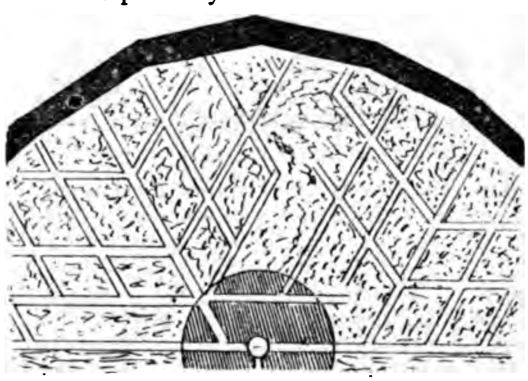
THE DERRICK.—It consists of a head-gear made of wood, which is placed over the top of the shaft, and a pulley is fixed in this head-gear. Another pulley is also fastened in the ground about 20 yards from the pit. Then a rope is attached to the tub and passed over the pulley in the head-gear, and thence under the pulley a short distance from the shaft. Then to the end of the rope a horse is attached and driven on in a straight line from the pulley, and by this means the material is raised from the shaft. After the tub has been emptied it is attached to the rope and the horse is brought back to the shaft, and the tub is lowered to be refilled.

HORSE-WHIM.—It consists of a vertical wooden axle made of oak about 12 inches in diameter and 12 or 14 feet long, which turns in a block of stone or iron casting at the bottom end, and in an iron socket at the top fixed in the span beams. This is made of Norway or Swedish fir, 36 feet long and about 10 inches square, supported by legs at each end which are morticed into the beam, and stays are joined between the span beam and legs. The rope drum or barrel is 6 to 8 feet in diameter, and beneath this is placed the driving beam, at each end of which a horse may be attached. The ropes are conducted over a little guide pulley from the drum to the pulleys fixed in the frame. As the horse travels around with the driving beam, one rope is wound on the drum and the other passes off.—(*Sketch of this appeared in Vol. 1, page 226*). THOMAS WEBSTER.

ADVANCED.

LONGWALL METHOD OF WORKING FLAT SEAMS.

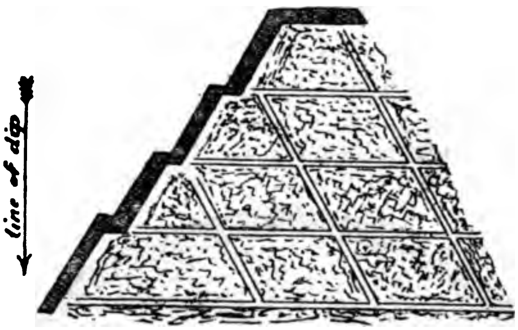
Question 2.—Describe two methods of longwall working, suitable for flat and inclined seams respectively. Give sketches.



Method of Working Comparatively Flat Seams.

Answer.—The following is a method of working comparatively flat seams, say from 1 in 6 to level, and in a seam of average thickness, viz., 4ft. :—After leaving sufficient coal pillar to support the shaft, I would con-

tinue the two main levels one on each side of the shaft, and out of these levels start jigs or roads about 200 yards, which could either be worked by jigging or balancing, or by pulleys and ropes off the main level haulage, and I would take cross roads every 80 yards for the purpose of cutting off the long length of drawing roads, and out of the cross roads start drawing roads, going straight to and at right angles to the working face about every 40 yards. For the convenience of getting coal from the face to the drawing roads, I should place the rails parallel to the face, which could be moved periodically as the face advanced. The working face should be supported by two or three rows of props placed parallel to the face, and chocks placed where they are most needed to prevent the weight caused by the waste settling on the coal face. In the drawing roads, cross roads and main levels, the roof should be ripped down to a sufficient height, and the debris used for putting in packs on each side of the drawing roads, and if the colliers holed in the under warrant the dirt could be placed behind them in the goaf. After drawing all the timber, but the two or three rows of props to support the face, the roof could be allowed to fall on the waste between the packs.



Method of Working Highly Inclined Seams.

The following is a description of a longwall method of working steep seams, say of about 50 or 60°:—The coal is extracted in one operation, and the dirt got from the ripping down of roads, and the holing dirt is thrown behind the colliers into the goaf. The working face is at an angle of about 45° with the dip, and is worked in a steplike manner, each face being about 15 or 20 yards wide, accommodating about five or six workmen. The idea being that if the roof was tender the weight would not come direct on the coal face, but would be distributed. It also serves as a safeguard to workmen, as the coal loosened by them in the step-face will not slide down and injure the colliers in lower ones. There is a drawing road at the lower side of each step-like face, and coal got at the higher side of it slides down to the drawing road where its progress is arrested, and is filled in tubs and sent out. The drawing roads are in a level direction, and cross roads or cross gates run diagonally across the dip, so as to make the tramming of the coals easier. J. PETERKIN.

FIRST-CLASS.

Question 3.—

(*a*) Has coal dust any effect on the flame of a lamp?

(*b*) How is coal dust dangerous in dry mines?

(*c*) Are all coal dusts alike inflammable?

(*d*) What precautions should be taken to minimise the danger?

Answer.—(*a*) To this question I answer yes, it has an effect on the flame of a lamp. Take the safety lamp for instance, to the careless observer it has no other effect than to choke the ventilation of the lamp by getting in the meshes of the gauze, and thus prevent the lamp from burning brightly. However, observe the lamp closely in an atmosphere charged with fine coal dust, and we will see the atoms of carbonaceous matter (not before they have touched the flame but afterwards) flying upwards in sparks of fire. These sparks are infinitely small, but in thousands around the flame; they elongate it and cause it to become more red and fierce, and make the lamp much hotter. I have also noticed the effect of coal dust on the flame of the lamp when a small cap of gas CH_4 has been present. I have examined the place which was an old stowage, or rubbish road, with a Cambrian fireman's lamp when no dust was in the atmosphere, and could just discern the faintest halo of gas round the flame, and afterwards when the atmosphere of the place was charged with fine dust, this blue halo was changed into a red cap quite three times the length it was previously.

(*b*) Coal dust is dangerous in dry mines owing to the fact that the flame from a blown-out shot, or even from a shot that has done its work, if accompanied with much flame, will ignite the dust which is raised with the force of the explosion, and thus cause an explosion of coal dust. This was proved in the Camerton explosion, because no gas was found in the colliery before or since, even though a portion of the workings was sealed

off for some months and then opened in the presence of the inspector of the district. It is also very dangerous when gas is present, for if a slight explosion of gas occurs the dust will be raised, and the explosion propagated and carried to distant parts of the mine. To my mind this was proved conclusively at Albion Colliery, as the mine had a splendid ventilation which was carried round on the separate split system, and if the explosion had been one of gas only, then it would only affect the district in which the explosion originated, but owing to the presence of coal-dust the explosion was propagated and swept the mine.

(*c*) All coal dusts are not alike inflammable, although all coal dusts are inflammable. Some coals are a great deal more susceptible to flame than others. A piece of cannel coal will light and flame up almost instantly, while a piece of anthracite coal is more difficult to light. This is due to the fact that the percentage of carbon is higher, and the percentage of combustible gases lower in anthracite than in cannel coal; and I am of the opinion that the dusts of the different coals would act in the same manner as the coals themselves.

(*d*) The precautions should be as follows to reduce the danger to its minimum:—All roadways should be kept clear from dust and an efficient system of watering employed, not only when shots are to be fired but at all times. Moreover, I would prohibit all shot-firing in fiery mines. This may appear a little too severe to some, but if we err, it is wise to err on the safe side. If this was done, we should very soon have more efficient mechanical appliances for hard ground, etc., because the old axiom is still true, that "necessity is the mother of invention." Therefore, all shot-firing in non-fiery mines should be carried on in strict accordance with the provisions of General Rule 12, C.M.R.A., as it is in such mines that workmen are more likely to be careless. WM. SLOCOMBE.

CORRESPONDENCE.

ANSWERS TO VENTILATION QUERIES.

Height of W. G. ·7, length of airway trebled, and velocity increased from 8 to 10 feet per second. What is the W. G. under altered conditions?

The question involves two laws of ventilation, namely, the first and second. The pressure varies in the first directly as the lengths, and in the second the pressure varies as the velocities squared. As the length of the road is trebled the W.G. would be ·7 × 3 = 2·1 W.G. If it now requires 2·1 W.G. for a velocity of 8 feet per second with the length trebled, what will it require for a velocity of 10 feet per sec.?

$$8^2 : 10^2 : 2{\cdot}1 : = \frac{100 \times 2{\cdot}1}{100} = 3\ 281 \text{ W.G.}$$

T. ARNOT.

Answers also received from C. H. S., A. Hart, &c.

Sir,—I offer a solution to the following question by "Constant Reader."

Find W.G., pressure, and H.P. to pass 90000 cubic feet of air per minute through an airway 8 x 6?

As there is no length of airway mentioned the question may be regarded as one having a bearing upon equivalent orifice. In the first place I will work the question as given, after which I will assume a length and work same. First—

$$P = \frac{K\ S\ V^2}{A} \qquad K = {\cdot}0217$$

$$K\ S = {\cdot}0217 \times 28 = {\cdot}6076$$

$$K\ S\ V^2 = {\cdot}0217 \times 28 \times 1{\cdot}875^2 = 2{\cdot}1358507100$$

$$P = \frac{K\ S\ V^2}{A} = \frac{2{\cdot}1358507100}{48} = {\cdot}0445 \text{ lbs. approx.}$$

$$\text{W.G.} = \frac{{\cdot}0445}{5{\cdot}2} = {\cdot}00855 \text{ ins.}$$

$$\text{H.P.} = \frac{{\cdot}0445 \times 90000}{33000} = {\cdot}0121$$

Assume that the airway is 1000 yards long:—

$$P = \frac{K\ S\ V^2}{A} = \frac{{\cdot}0217 \times 84000 \times 1{\cdot}875^2}{48} = 133{\cdot}5 \text{ lbs. pres.}$$

$$\text{W.G.} = \frac{133{\cdot}5}{5{\cdot}2} = 25{\cdot}67 \text{ ins.}$$

$$\text{H.P.} = \frac{90000 \times 133{\cdot}5}{33000} = 364 \text{ nearly.}$$

The above pressure will never be obtained in actual practice, as there would be several splits to pass such a quantity of air. It would be impossible to carry a light against such a velocity, at least it would be difficult to do so.

The following are details as to how the various items are found:—

Let A = Area
K = Co-efficient of friction
S = Rubbing surface
V^2 = Velocity in thousands of feet per min.
P = Pressure per square foot

$$V = \frac{90000}{48} = 1875 \text{ feet} \qquad V^2 = \left(\frac{1875}{1000}\right)^2 = 1{\cdot}875$$

$$S = \text{Perimeter} \times \text{Length}$$
$$= 8+8+6+6 \times 3000 = S = 28 \times 3000 = 84000$$

$$P = \frac{K S V^2}{A} \qquad A = \text{Height} \times \text{Width} = 8 \times 6 = 48$$

Note, the pressure in the first case was ·0445 lbs without length, but now it is lengthened to 3000 feet, and this multiplied by the pressure, thus ·0445 × 3000 = 133·5 lbs. Pressure varies directly as the rubbing surface in this particular case. C. H. S.

Steam Query.

Sir,—Probably some of your readers will give me an answer to this question:—Does back-pressure in a steam cylinder reduce the quantity of heat rejected by the steam. That is, suppose we have no back-pressure and the heat rejected by the steam is equal to the heat of its formation, if back-pressure occurred from any cause would the heat rejected be less or greater?—C. Albert Hart.

Queries on the Syphon and Fans.

Sir,—An answer to the following questions will oblige:—(1) What is the motive power of a syphon and how can that power be applied? Give details. (2) Whether is a propelling or an exhaust fan the best? Give reasons. (3) Why is an exhaust fan so popular?—Eager.

Ventilation Query.

Sir,—An air-current is split into three, A, B, and C, and the quantity split is equal to 80,000 cubic feet per minute, what quantity will each get, supposing them all to have the same sectional area. A is 2000 yards long, B is 4000 yards, and C is 6000. An answer in plain figures will oblige.—Anxious.

Size of Engine Required.

Sir,—It is required to draw 400 tons of mineral from a depth of 600 yards in 10 hours. Cages holding four tubs each, tubs weighing about 6cwt. each and carrying 12cwt. of mineral. Would some reader kindly show how to find size of rope, diameter of drum, and size of cylinders, and length of stroke of engines, steam pressure 75 lbs.—J. P.

Water Jet and Brandt's Hydraulic Borers.
Körting's Aspirator.

Sir,—In the Science and Art Department Syllabus of Mining, under the head of Deep Boring, appears the Water Jet Borer and Brandt's Hydraulic Pressure Borer, and under the head of Ventilation, appears Körting's Aspirator. I would be obliged if some of your readers would describe these.

A Honour's Candidate.

COMPETITION QUESTIONS.

No. 14 SET.

To the sender of the best set of Original Answers in each Stage will be awarded the following:—

Elementary 2s. 6d., Advanced 3s. 6d., First-Class 4s. 6d.

A Competitor may only answer one Stage. The best answer to each question will be published with the sender's name and address.

1.—All envelopes must be marked "Competition."

2.—To be written on separate sheets of paper with name attached, and on one side of the paper only. Sketches to be in ink (Indian ink preferred) on *unruled* paper.

3.—Correct name and postal address must be sent.

4.—They must reach us by May 3rd, 1895.

5.—The Editor's decision as to winners to be final.

ELEMENTARY.

Question 1.—Compare briefly the relative advantages and disadvantages under different conditions of chains, hemp rope, and iron and steel wire rope.

Question 2.—Describe with sketch the ordinary timbering of a level.

ADVANCED.

Question 3.—Describe what you consider to be one of the best of modern fans. Give sketch.

FIRST-CLASS.

Question 4.—What are the principal gases in a mine before an explosion of firedamp and of coal dust. Give an account of the resultant gases and how they are formed.

Question 5.—Which do you consider the better, an air-crossing sufficiently strong to resist an explosion, or one that would be destroyed? Give reasons for your answer.

Important Notice to Competitors.

Competitors who have gained a First-Class Elementary in Mining (Science and Art Department) or other Examination are *not* eligible for the Elementary Stage.

Competitors with First-Class in the Advanced Stage, and those possessing First or Second-Class Certificates of Competency are only eligible for the First-Class Competition.

Those students who are not at present complying with the above will please do so at once.—Editor.

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MINING

A JOURNAL DEVOTED TO THE INTERESTS OF MINING STUDENTS

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CONTENTS.

EASY LESSONS ON

MINE VENTILATION.

By J. CARTER, First-Class Certificated Manager.

(Commenced in No. 9, Vol. III.)

FURNACE VENTILATION.

THE barometer and thermometer are very important factors in calculations of furnace ventilation. The power produced by the furnace is consequent on the rarefaction of the air caused by the heat of the fire. Air on being heated rarefies and expands, and the volume of air in the upcast shaft is thus made considerably lighter than that of the downcast, which, although it may be only of the same depth, is heavier by reason of its lower temperature. To calculate this power we must find the weight of a cubic foot of air in each shaft, the greater this difference can be maintained the greater the amount of ventilation will be obtained.

The following are some of the principal problems and rules required in connection with the power, etc., of furnace ventilation:—Motive column. This may really be called a measure of the pressure in force producing the ventilation, and should it be required to express it in pounds per square foot it can be calculated as follows:—Multiply the depth of each shaft in feet by the weight of one cu. foot of air at the average temperature of that shaft, and deduct one from the other. This difference will be the pressure per sq. foot producing ventilation.

The motive column is found as follows:—

M = Motive column in feet

T = Average temperature of air in upcast

t = Average temperature of air in downcast

D = Depth of each shaft in feet

Rule— $$M = D\,\frac{T - t}{T + 459}$$

Example:—Say the depth of the upcast and the downcast shafts were each 400 feet (diameters of shafts 15 feet, which gives an area of 176·715 sq. feet), the temperature of the downcast 60° F., and the average temperature of the upcast 160° F., find motive column? Thus in this case D = 400, T = 60°, t = 160°. Air expands $\frac{1}{459}$ for every degree F. of heat added:—

$$\therefore\ M = 400 \times \frac{160 - 60}{160 + 459} = 400 \times \frac{100}{619}$$
$$= 400 \times {\cdot}1615 = 64{\cdot}6 \text{ feet}$$

That is, the air in the downcast shaft would balance the air in the upcast shaft with 64·6 feet shorter column than the upcast.

We must now consider the rule for finding the weight of a cubic foot of air in decimals of a pound avoirdupois, at different temperatures:—

T = Temperature

B = Barometer

W = Weight of a cu. foot of air

Rule— $$W = \frac{1{\cdot}3253 \times B}{459 + T}$$

Taking the above examples, say barometer stands at 30. Find the weight of a cubic foot of air in each of the above-named shafts?

$$\therefore\ \frac{1{\cdot}3253 \times 30}{459 + 60} = \frac{39{\cdot}759}{519} = {\cdot}0766 \text{ lbs. D'cast.}$$

$\therefore \frac{1 \cdot 3253 \times 30}{459+160} = \frac{39 \cdot 759}{619} = \cdot 0642$ lbs. Upcast.

The weight of a cubic foot of air in the downcast equals ·0766 lbs., therefore the pressure at the bottom of the pit would be $\cdot 0766 \times 400 = 30 \cdot 64$ lbs.

In the upcast we should have $\cdot 0642 \times 400 = 25 \cdot 68$ lbs. $\therefore$ $30 \cdot 64 - 25 \cdot 68 = 4 \cdot 96$ lbs. pressure on each square foot producing ventilation.

Suppose we had 200000 cubic feet of air passing with a pressure of 4·96 lbs. Find horse-power of ventilation ?

$$\frac{200000 \times 4 \cdot 96}{33000} = 30 \cdot 06 \text{ H.P.}$$

Horse-power = 33000 lbs. lifted 1 ft. per min., or 1 lb. lifted 33000 feet per min.

To obtain the velocity from motive column the rule is that a body falling under the force of gravity would attain a velocity of 8·025 times the square root of its height. Therefore, take the square root of motive column and multiply by 8·025, the result obtained will be the velocity in feet per second of air without resistance.

Taking the motive column as 64·6, as in the previous example, other calculations such as the following can easily be obtained.

$$\sqrt{64 \cdot 6} \times 8 \cdot 025 = 8 \cdot 037 \times 8 \cdot 025 = 64 \cdot 49 \text{ V p. sec.}$$

$$64 \cdot 49 \times 60 = 3869 \cdot 4 \text{ feet per min.}$$

This points out clearly to us that were it not for the resistances encountered by the air in passing through the workings of a mine a very small pressure would be sufficient to produce a velocity equal to the requirements of our modern mines. But on account of the friction air meets with by rubbing against the sides of airways when passing through the underground workings, we find that in practice from ten to twenty times as much pressure is required to give that speed to the air which would suffice for final velocity. For example :—

Water-gauge $\times$ 5·2 = pounds per sq. foot.
Pounds per sq. foot divided by ·0763 = length of motive column.
V = Velocity in feet per second, in this case = 5 feet.
M = Motive column, in this case = ·39.
W.G. = Water-gauge.
P = Pressure in lbs. per sq. foot.

$$V = 8 \cdot 025 \sqrt{M} \qquad M = \frac{V^2}{64 \cdot 4}$$

$$\text{W.G.} = \frac{\frac{1 \cdot 3253 \times 30}{459 \times t} \times M}{5 \cdot 2}$$

$$V = 8 \cdot 025 \times \sqrt{\cdot 39} = 8 \cdot 025 \times \cdot 6245 = 5 \text{ft. per sec.}$$

$$M = \frac{V^2}{64 \cdot 4} = \frac{5 \times 5}{64 \cdot 4} = \frac{25}{64 \cdot 4} = 39 \text{ nearly M. Col.}$$

$$\text{W.G.} = \frac{\frac{1 \cdot 3253 \times 30}{459 + t} \times M}{5 \cdot 2} \quad \frac{\frac{39 \cdot 759}{459 + 62} \times \cdot 39}{5 \cdot 2}$$

$$= \frac{.0763 \times \cdot 39}{5 \cdot 2} = \cdot 0057 \text{ W.G. in ins. necessary}$$

to produce the theoretical final velocity.

I here give a few results in tabulated form (so that the student may work them out for himself), showing the amount of the motive column of air and inches of water-gauge necessary to produce the theoretical final velocity in upcast shaft at different temperatures of air :—

$$V = 8 \cdot 025 \times \sqrt{M} \qquad M = \frac{V^2}{64 \cdot 4}$$

$$\text{W.G.} = \frac{\frac{1 \cdot 3253 \times 30}{459 \times t} \times M}{5 \cdot 2}$$

Velocity in ft. per sec. V	Motive Column of Air. M	W.G. in decimals of an inch at the following temperatures. 80 deg.	100 deg.
3	·139	·0019	·0018
9	1·257	·0178	·0711
16	3·975	·0563	·0544

Take an example: A mine whose water-gauge measures 2·5 inches, which represents the whole friction of a mine. The final velocity of the air in the upcast shaft is 32 feet per second, which is obtained in many shafts. Barometer, 30°, the temperature of which we may say is 140°. It will be found by calculation that 2·297 is due to friction, and it requires only a decimal portion to produce the velocity.

The water-gauge due to final velocity may be found thus :—

$$\text{W.G.} = \frac{\frac{32^2}{64 \cdot 4} \times \frac{1 \cdot 3253 \times 30}{459+140}}{5 \cdot 2} = \frac{15 \cdot 9 \times \cdot 0663}{5 \cdot 2}$$

$$= \frac{1 \cdot 05417}{5 \cdot 2} = \cdot 203 \text{ nearly, water-gauge.}$$

Thus the water-gauge due to friction equals $2 \cdot 5 - \cdot 203 = 2 \cdot 297$.

In order that this amount of power may be kept as low as possible good airways should be maintained and shafts should be of large area, as we shall see later on what an important part they play in the course of ventilative power.

I have pointed out that pressure obtained from a furnace depends mainly upon the amount of heat communicated to the air in the upcast shaft, and for the current to be regular it necessitates the furnace to be kept constantly at the same degree of heat.

(*To be continued.*)

THE SCIENCE & ART DEPARTMENT MINING EXAMINATION.

The above examination takes place on May 7th, and as we have a considerable number of elementary students amongst our readers who purpose sitting, and who are unaware as to the probable nature of the examination, we append a few questions taken from previous examination papers, answers to which they would do well to look up. The answers to all the questions have appeared in "Mining" at one time or another.

ELEMENTARY QUESTIONS.

(1) Describe the usual methods of timbering levels.

This question may be varied a little by stating the nature of the roof, floor, or sides.

(2) What is a fault, and what method is usually adopted to find the continuation of the coal seam?

(3) What methods are generally adopted for ventilating the end of workings in mines?

There are a number of ways of expressing the end of workings, as "the forebreast of a level," and "a level beyond a main airway."

(4) Describe the principle of the safety lamp, and the construction of one of the best forms. Under what conditions do they become unsafe?

(5) What gases are met with underground, how are they detected, and which are dangerous?

(6) What is coal, how is it found, and what is the general nature of the deposit?

(7) Numerate the different kinds of coal, and where they are chiefly found in the United Kingdom?

(8) Describe the operations of getting coal in a longwall working with illustrations.

(9) How are mines kept free from water?

(10) Describe the operations of sinking a shaft in loose surface strata, and afterwards securing it with brickwork.

(11) What is the pillar and stall system of coal working, and by what other name is it known?

(12) Describe a furnace used for ventilation underground, and what is the use of the dumb drift?

(13) What are the principal kinds of rope used in mines?

(14) Describe the ordinary method of boring with rigid rods.

In addition to the above questions, the description of the following appliances should be learned:—Common and lift pump, syphon, picks, windlass, derrick, horse-whim or gin.

COMPETITION QUESTIONS.

No. 15 SET.

TO the sender of the best set of Original Answers in each Stage will be awarded the following:—
Elementary 2s. 6d., Advanced 3s. 6d., First-Class 4s. 6d.
A Competitor may only answer one Stage. The best answer to each question will be published with the sender's name and address.

1.—All envelopes must be marked "COMPETITION."
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3.—Correct name and postal address must be sent.
4.—They must reach us by May 17th, 1895.
5.—The Editor's decision as to winners to be final.

ELEMENTARY.

Question 1.—How is the forebreast of a level ventilated?

Question 2.—Describe the general structure of a coalfield.

ADVANCED.

Question 3.—Describe briefly by means of sketches how levels are timbered in steep seams?

Question 4.—How do fires originate in coal mines, and what means are usually taken to extinguish them?

FIRST-CLASS.

Question 5.—A colliery with a hundred hewers in a shift is ventilated by a current of 150,000 cubic feet per minute. Draw a sketch of bord and pillar, and longwall working for it, showing number of workmen in each district, the coarse of the air splits, stoppings, &c., and give proper dimensions for return airways, also quantity of air in each split.

KÖRTING'S ASPIRATOR.

THIS appliance has been designed for inciting a ventilation current in the end workings of a mine which are difficult to ventilate. It is worked by compressed air which is conducted to the jet ventilator in small pipes as shown by fig. 2. The compressed air pipes are connected to the flange *d* (fig. 1), and the supply is regulated by the wheel *D*. The quantity of air which they deliver can be easily and rapidly increased or decreased by this means without stopping the action of the ventilator. The appliance works on the principle of the steam injector, the compressed air entering at *d* and passing along towards *L* at a high velocity, induces a current of air to set up in the direction shown by the arrows *s*, which air, together with the compressed air, passes along the conduits to the forebreast of the level or other working. The fixing of the air-pipes is very easily effected. If the apparatus is to be connected to zinc pipes, the pipe is simply slipped over it at the end *e*. When wood conduits are used the ventilator is simply put into them so that no support is required. At the proper point the conduit is closed by a piece of board provided with a hole corresponding to the opening at *e*. These ventilators are of so light a construction that one man can fix them or change their position. The ventilator can be arranged either to blow the air forward or to exhaust, the efficiency always being the same. The price of the aspirator varies from £9 to £25. With a 6 inch diameter air conduit, and a corresponding size of ventilator, which costs about £9, and with compressed air of 45lbs. pressure, passing along a ¾ inch pipe, the ventilator will deliver 450 cubic feet per minute with air conduits of 300 feet. With 16 inch diameter air conduits, and corresponding size of jet ventilator (price £25), with air at 45lbs. pressure delivered in 1¾ inch pipes, the quantity of air delivered is 3,300 cubic feet per minute along air conduits of 300 feet in length. The makers of this apparatus are Messrs. Körting Bros., 53, Victoria Street, Westminster, who will be pleased to give any further information as to its cost and working.

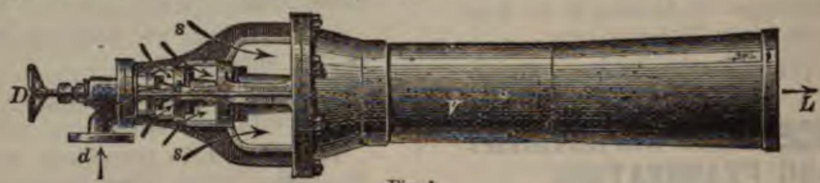


Fig. 1.

Fig. 2.

AWARDS

For Answers to Competition Questions—No. 12.

ELEMENTARY.—J. H. Senior, 16, Thompson Row, High Street, Rawmarsh, Rotherham.
Commended—T. Webster, J. Fell, W. Walker, F. Cherry, A. Dixon, J. Wheatcroft, C. Barrow.

ADVANCED—Wm. Sutherland, Granville Terrace, Liverpool Road, Hindley.
Commended—W. Roberts, T. H. Dixon, R. Hill, J. R. Pugh, T. Lawrenson, J. Stephenson, H. Hall, J. Jones. T. E. Aitchison, J. Crone, F. Gregory, H. Talbot, J. Hodgson.

FIRST-CLASS—M. Brown, Butterknowle, Darlington.
Commended—A. Alderson, S. Thorpe, J. Davies, J. McPhail, E. A. Lodge, W. Slocombe, E. Jones, H. Bennett, J. H. Harrison, B. S. Broadhurst, S. Davies, G. Daykin, G. A. Hawes, J. G. Bell.

EXAMINATION QUESTIONS ANSWERED.

By a First-Class Certificated Manager.

Questions given at the Manchester Examination for First-Class Certificates of Competency, Dec., 1894.

I.—Arithmetic.

Q. 1.—If the total pressure upon a separation door is 400 lbs. when the w.g. is $2\frac{1}{4}$ inches, what is the area of the opening and what is the height of the door when its breadth is 5 feet 6 inches? (3 marks.)

A.—1 inch of w.g. = 5·2 lbs. per sq. foot, $\therefore$ $2\frac{1}{4}$ ins. $= 5{\cdot}2 \times 2{\cdot}25 = 11{\cdot}7$ lbs. per sq. foot. If the pressure on the door is 11·7 lbs. per sq. foot and the total pressure is 400 lbs., the area of the door or opening =

$$\frac{400}{11{\cdot}7} = \underline{\underline{34{\cdot}18 \text{ sq. feet.}}}$$

Height × breadth = area

$$\therefore \frac{34{\cdot}18}{5{\cdot}5} = \underline{\underline{6{\cdot}21 \text{ ft. height of door.}}}$$

Q. 2.—The distance from an airway to an upcast pit is 76 yards, measured upon the level. What would be the length of a dumb-drift out of the airway to come into the pit at a height of $32\frac{1}{2}$ yards above it? (3 marks.)

A.—The square of the length of the hypothenuse of a right angle triangle is equal to the sum of the squares of the lengths of the other two sides. We may assume the length of the dumb-drift to be the hypothenuse of a right angled triangle whose other two sides are $32\frac{1}{2}$ and 76.

Then $\sqrt{32\frac{1}{2}^2 + 76^2} = \underline{\underline{82{\cdot}6 \text{ yds. length of drift.}}}$

Q. 3.—A hoppit measures 3 feet 9 inches in depth, 3 feet 6 inches diameter at top, and 2 feet 8 inches diameter at bottom. What weight would it hold at 14 cubic feet per ton; or what weight of water would it hold? (3 marks.)

A.—Mean diameter = 3ft. 6in. + 2ft. 8in. ÷ 2 = 3ft. 1in. To find the area of a circle, square the diameter and multiply by ·7854:—(3ft. 1in.)^2 or $3{\cdot}08^2 \times {\cdot}7854 = 7{\cdot}45$ sq. feet. Area of mean diameter × depth = cubical contents. $\therefore$ $7{\cdot}45 \times 3{\cdot}75 = 27{\cdot}93$, say 28 cubic feet. If 14 cubic feet = 1 ton of rock, 28 cu. ft. would hold $28 \div 14 = \underline{\underline{2 \text{ tons of rock.}}}$

Water weighs 62·5 lbs. per cubic foot $\therefore$ 28 cu. ft. will weigh $62{\cdot}5 \times 28 = \underline{\underline{1750 \text{ lbs. of water.}}}$

II.—C.M.R.A. and Special Rules.

Q. 4.—What are the General Rules relating to dimensions and securing of the various working roads in a mine? (4 marks.)

A.—General Rule 17 states:—Every travelling road on which a horse or other draught animal is used underground shall be of sufficient dimensions to allow the horse or other animal to pass without rubbing against the roof or timber.

General Rule 21 states:—The roof and sides of every travelling road and working place shall be made secure, and a person shall not, unless appointed for the purpose of exploring or repairing, travel or work in any such travelling road or working place which is not so made secure.

General Rule 1 states:—That the travelling roads to and from the working places shall be in a fit state for working and passing therein.

Q. 4.—State shortly the manager's duties with respect to the use of safety lamps, as defined by the Special Rules of this district? (4 marks.)

A.—The manager shall order locked safety lamps to be used whenever requisite to comply with the Act, and shall specify of what type and pattern of safety lamp. He shall fix lamp stations at such points as he shall think fit, not being in any return aircourse, at which lamps may be lighted and relighted, and shall also fix a point in the mine, or in the ventilating district, beyond which no light other than a locked safety lamp shall ever be taken. He shall also appoint a competent person who shall, either at the surface or at the appointed lamp station, examine every safety lamp before it is taken into the workings for use, ascertain it to be in safe working order, and securely locked.

Q. 5.—What are the duties of the under-manager and fireman with respect to the provision and use of timber? (4 marks.)

A.—General Rule 22 states:—Where the timbering of the working places is done by the workmen employed therein, suitable timber shall be provided at the working place,

gate-end, pass-bye, siding, or other similar place in the mine convenient to the workmen, and the distance between sprags or holing props when they are required shall not exceed six feet or such less distance as may be ordered by the owner, agent, or manager.

Q. 6.—What is the General Rule relating to the construction of safety lamps? (4 marks.)

A.—General Rule 9 states:—Wherever safety lamps are used they shall be so constructed that they may be safely carried against the air-current ordinarily prevailing in that part of the mine in which the lamps are for the time being in use, even though such current should be inflammable.

Q. 7.—In firing a shot in a sinking pit, what is the mode of procedure before firing and what precautions must be taken? What must be done after firing before work is resumed? (4 marks.)

A.—The banksman shall immediately before shots are to be fired ascertain from the engineman that the hoppit or tub is in proper position and that he is ready at once to draw away on receipt of the signal to do so; he shall then signal to the bottom of the shaft to this effect. The chargeman shall not allow any shot to be fired except under his supervision, nor until the hoppit or tub is conveniently placed and a signal has been received from the surface that the engineman is in perfect readiness to draw away. The chargeman after cessation of work, whether caused by the withdrawal of the workmen for shot firing purposes or other causes, shall, accompanied at least by one other person, descend and examine the pit and ascertain it to be safe before allowing the rest of the men to descend; and after the firing of a sumping or breaking down shaft, or when inflammable gas is likely to be given off, such examination shall be made with a safety lamp.

Q. 8.—What are the duties of a boiler minder or stoker as set out in the Special Rules? (4 marks.)

A.—He shall not exceed the allowed pressure of steam, and shall maintain a proper depth of water in each boiler. Should anything prevent this, he shall at once withdraw the fire and report the same to his superior officer and the engineman.

He shall carry out the instructions of his superior officers with respect to the working and regulation of the safety valves, steam guages, water guages, feed-water valves, and other appliances, and shall see that they are kept free and in good order.

If no other person be appointed for the purpose, he shall examine every boiler internally after cleaning or repairing, also the mountings, and shall make a true report of the state of the same to the enginewright boiler inspector or superior officer.

He shall see that the General and Special Rules applying to his department are strictly observed, and shall immediately report any non-observance to the manager.

(To be continued.)

THE ENGINEERING OF COLLIERIES

Being a Treatise on Colliery Machinery, Appliances, and Constructions.

By T. A. O'DONAHUE.

(COMMENCED IN No. 9, VOL. III.)

WINDING.—CONTINUED.

ROPE CONDUCTORS. Wire rope conductors are undoubtedly the best, as has been previously stated, when the circumstances will admit of their adoption, and it is only with the most unfavourable conditions that they cannot be employed. Rope conductors are very suitable to the high speeds of winding now prevalent, friction being reduced to a minimum. The first cost is cheaper than for rigid guides and the wear is excellent. They are comparatively easy to fix, and numerous buntons in the shaft are not required. The ropes used for conductors, unlike winding ropes, are made of wire of large diameter, so that the strands will not break after a little wear. If, as was at first the case, ordinary winding ropes were used very little wear would be sufficient to break one of the wires, and the whole rope would be quickly damaged by the guiding shoes passing up and down. The work also of winding ropes and rope conductors are entirely different; whereas the winding rope requires to be of great strength, this is not so essential to the rope conductor, but it must be capable of allowing its circumference to be reduced to a certain extent by friction without materially damaging the rope.

The ropes are passed through the topmost cross-timbers of the head-gear and are held secure by two or three clamps (fig. 13). They are kept taut in the shaft either by suspending heavy weights to the bottom or by connecting them to a bunton fixed at the bottom of the shaft and screwing them up tight. There is a serious objection to the latter method, however, insomuch that no allowance can be made for expansion and contraction of the rope. The weight is the better arrangement, as the rope adapts itself automatically to thermometric or other changes. A common arrangement of attaching the weights to the guides was by fixing several clamps at the bottom of the rope in the same way that the rope is secured at the top (fig. 13), and these supported the cylindrical weights. This is a poor arrangement, as the rope surrounded by the weights is liable to corrode and it is difficult to inspect. A better plan is that shown by fig. 14. The rope is capped to a strong iron rod, on to which the weights are placed. The capping of the rope is similar to that adopted for flat ropes, and in my opinion a similar capping for suspending the rope at the top is preferable to the clamps.

Fig. 13.

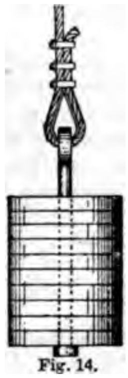


Fig. 14.

At a large colliery with which the writer is acquainted, the method of fastening the ropes both at the top and bottom is by welding to rods of iron. The rod at the top has a screw turned on it, is passed through a hole in the cross-beams of the head-gear, and is held by two or three nuts. A hole is cut in the rod at the bottom for the insertion of a strong cotter on to which the weights rest. This method has been in practice for many years and is considered very efficient. It is stated that the welding is quite as strong as any other part of the rope, and when once turned out of the workshop has never failed; of course if the joint was a bad one it would be broken and a new one made.

The cage is secured to the guides by shoes or thimbles (fig. 15), which enclose the rope. As will be seen by the sketches the shoes consist of two parts, in order that the cage may be easily attached and detached from the guides when required, and also to renew the cast-iron bushes when worn, with which the shoes are fitted. The back half of the shoe has two projecting pieces at the top and bottom, by means of which it is fastened to the cage, and also two side pieces which are shown in the front view, to which the outer half of the shoe is secured.

Fig. 15.

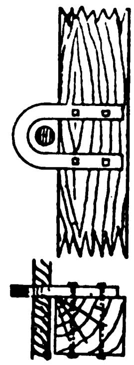


Fig. 16.

There is no advantage to the practice, which is sometimes adopted, of having the weight for each rope in one solid piece, as they are very heavy and cumbersome. When a number of weights, of about 2cwt. each, are used, there is a hole in the centre of each, and a slot is cut from the circumference to the centre so that they may be placed on the rod. It is a wise practice to have this slot made conical, both longitudinally and in section, so that after the weight has been placed on the rod, a conical piece of iron may be dropped into the slot and thus prevent the weight from slipping off. The total weight attached to each rope varies from 30cwt. in shallow shafts to 4 tons in deep shafts, but the actual weight which should be put on guides of a certain length can be best ascertained by actual testing.

In order to prevent excessive vibration the guides are attached to buntons at the bottom of the shaft. The ropes should not be passed through the centre of the buntons as is sometimes done, but should be held loosely at the side by means of a staple (fig. 16). At one of the most extensive collieries in this country the weights are suspended into cylinders of tar to still further reduce the vibration.

The usual number of guides to each cage is three or four, but in some cases where there is very little clearance space for the passing of the cages two additional ones are suspended between the cages to prevent contact.

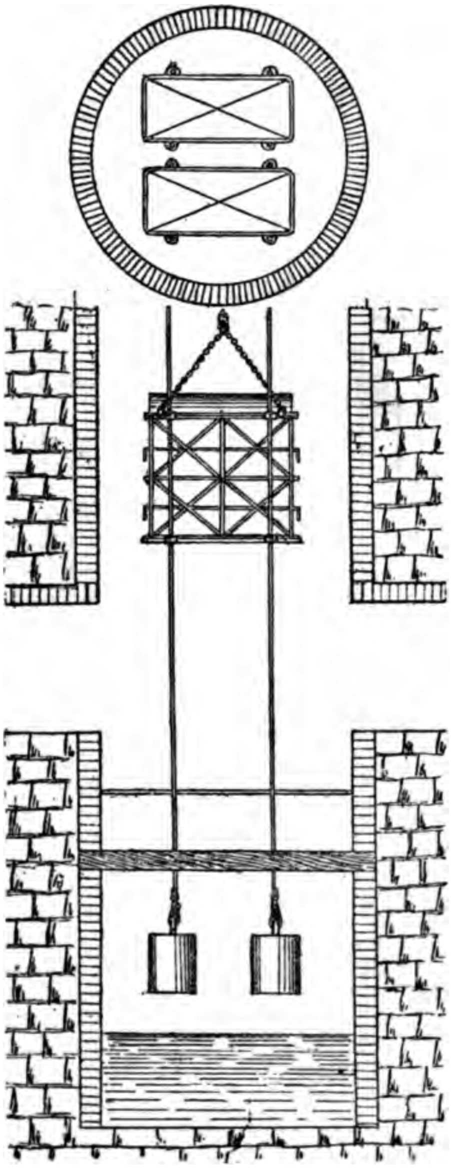


Fig. 17.

For deep shafts the cages should have a clearance with the shaft walling of from 9 to 12 inches, and they should be from 12 to 18 inches apart. Fig. 17 shows plan and elevation of a shaft fitted with two cages, with four guides to each. The arrangement of the weights at the bottom of the shaft is also clearly shown.

Fig. 18 shows a method of fixing the guides in a shaft which affords very little clearance to the cages. There are three guides connected by thimbles or shoes to the outside of each cage, whilst the two on the inside hang free and are not connected to either cage. Rubbing strips are fitted on to the cages so that they may not be damaged. The outside conductors guide the cage and keep it in its proper position, whilst those between the cages prevent them from colliding at meetings. In some cases where the space is not so limited as that shown in the sketch, yet not so great as to prevent collision in a deep shaft the guides are attached as usual to both sides of the cages and rubbing pieces are placed on the outside of the inner guide shoes and two extra guides are hung free between the cages, so that the extra guides and rubbing pieces are not used except when the guides are vibrating excessively.

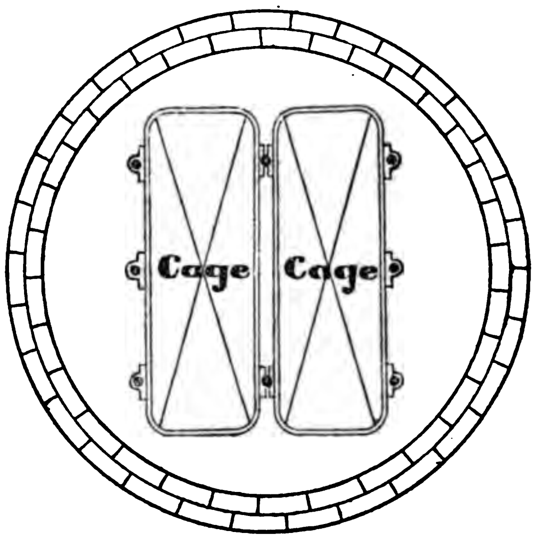
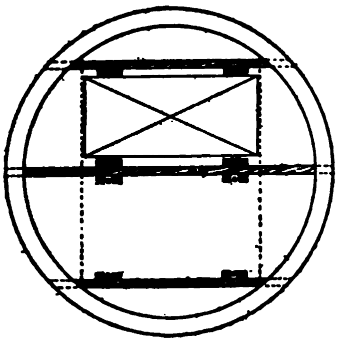
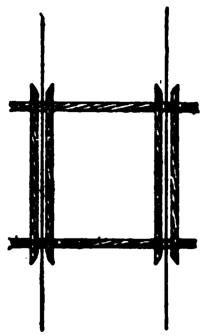


Fig. 18.

A few inches of vibration in the shaft is of little consequence, but in order to deck the tubs properly it becomes necessary to limit the clearance of the cages at the landings to a very small amount. This is effected by fixing a kind of trough (figs. 19 and 20) round the rope at the landings. The trough may be constructed of two pieces of angle iron, one placed a few inches on each side of the rope and a flat piece on the back, all fastened to cross-buntons; or it may be formed of vertical pieces of timber as shown in sketch. The trough is made a little wider than the guide shoes and is bell-mouthed at top and bottom to ensure the guide shoe passing into the trough properly.



Plan.
Fig. 19.



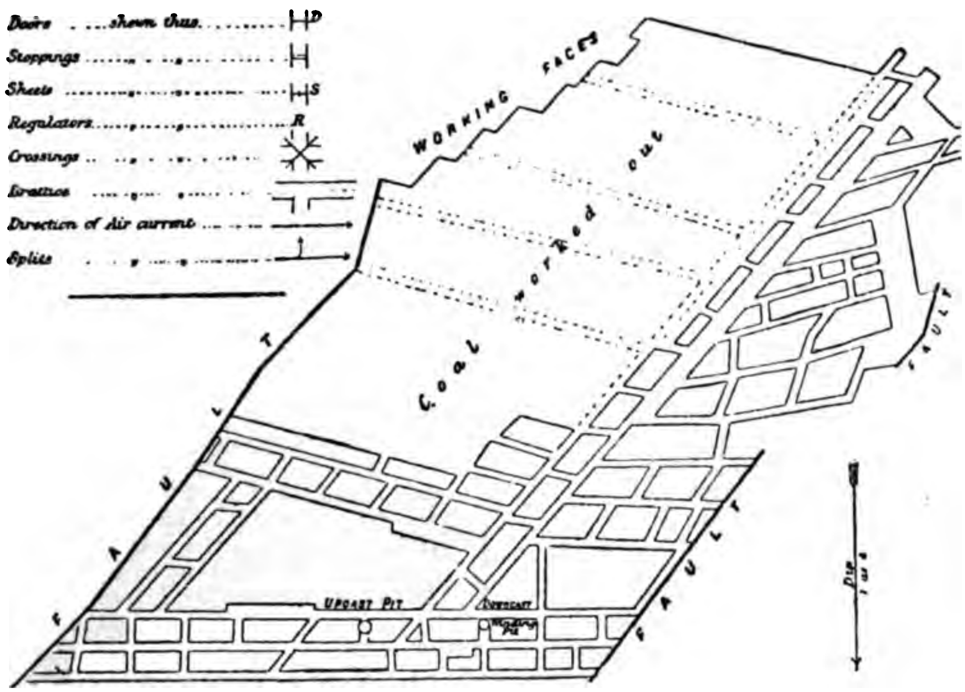
Elevation.
Fig. 20.

Unless some definite system of lowering and fixing the guides in the shaft is followed, they may give considerable trouble. Perhaps the best method of lowering each rope is to coil it on the drum of the winding or auxilary engine from the the turntable on which it is usually first placed, and then pass it over a main or secondary pulley of the head-gear and lower it gently, a weight being connected to the bottom to keep it taut. It should then be fastened to the side of the shaft so as to be out of the way while the others are being lowered, and these should be treated in the same manner until the whole of the guides are in the shaft, when they may be fixed in the proper position one by one as required. Each rope may be held at the top by clamps, which are secured, not at the end, but several feet away, so that the end may be free to fix in its proper position before the clamps are detached.

(To be continued.)

VENTILATION PLAN.

Given at the Manchester Examination for First-Class Certificates of Competency.—1891.



We will publish the above plan shewing a method of ventilating same in next issue.

STUDENTS METHOD OF VENTILATION CRITICISED.

We will criticise a student's method of ventilating the above plan, explaining its deficiency, and what should be considered under the circumstances, at a charge of 6d. each.

Envelopes to be marked " Plan."

ANSWERS TO QUESTIONS

No. 12 Set—In No. 9, Vol. III.

ELEMENTARY.

THE SCIENCE OF GEOLOGY.

Question 1.—State in your own words what use the science of geology is to coal mining?

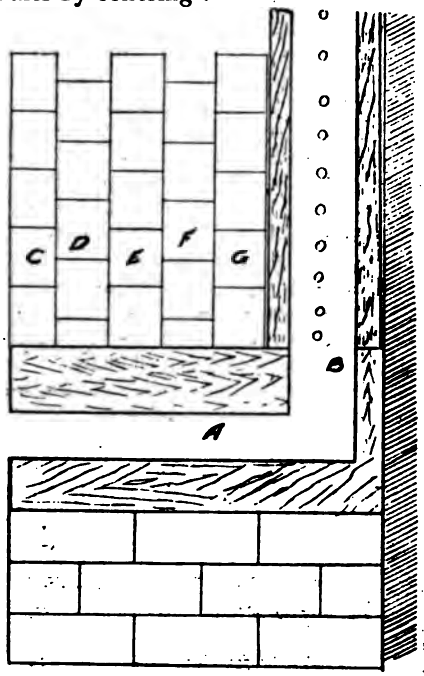
Answer.—Geology is a science which greatly aids us in the various operations that are connected with coal mining, and every student who is pursuing the latter with deep interest, should have a very fair amount of this science instilled into his mind. Geology is that branch of science which deals with the structure of the earth, and the various causes by which it has been brought into its present condition, and also the various causes which are now at work producing further changes. It unravels the complicated process by which the valleys, hills, and mountains have been built up. It gives us a glimpse into the past history of our earth, and shows us a variety of life forms of both animals and plants which occupied our earth long before man visited it. It tells us of the origin of the earth, what it is composed of, how land and water have alternately changed places with each other, and one kind of animal life given place to another. We have many facts which testify that the earth did not come into existence as we find it. Its rocks have been built up by the slow action of natural agencies. The rocks themselves often contain their historical record. Some of these rocks often enclose the remains of plants and also of animals, which we know could not have lived in the heart of a solid rock; therefore the sediment forming the rocks must have in some way gathered round them and enclosed them in. Again, many of the remains of animals which are found in the rocks belong to creatures that lived in water, large numbers of them being marine creatures. These facts clearly indicate that this class of rocks were formed underneath the sea. In our search among the rocks we find that the fossils in one group differ altogether from the fossils found in another group, and from this we come to the conclusion that as one species of creatures died out another was supplanted in its place. Coming to the present time, geology shews us the agents now at work producing further change, such as frost, rain, wind, the sea, the rivers, and even burrowing animals, a study which if taken into our minds affords us much information and instruction, and is also very interesting. Geology is of the utmost importance in mining operations, as it enables us to form a very accurate opinion whether coal exists under an estate, and in sufficient quantities to make a fair return for the money about to be invested. It enables us to ascertain dip and direction of the measures, also the probable depth of the seam from the surface. It also explains all the terms used in geology in connection with coal or mineral seams, such as dykes, faults, veins, rise, outcrop, strike, synclinal and anticlinal, trough, contorted, comformable, unconformable, monoclinal, periclinal, escarpement, &c., and any other terms, all of which every mining student should know, and by studying geology he will find all these terms are very clear and easily understood, and it is essential to coal mining. To an engineer a knowledge of geology is indispensable, as the knowledge of the geological structure of an estate becomes necessary in fixing its real value. Geology also teaches us the definite order of succession of rocks, and in searching for coal or any other mineral, we proceed to make a careful examination of the earth's surface for indications as to whether coal or mineral is underlying an estate, and as each group of rocks as stated above, contains its own characteristic fossils, a knowledge of them is of the greatest advantage in the work of prospecting, and here a knowlege of geology is essential. Making use therefore of every kind of evidence, which the surface and the earth's crust afford, the geologist endeavours to weave together the history of the earth. Geology also teaches us of the metamorphic system, Cambrian group (upper and lower portions), Silurian system, the Devonian or old red sandstone, aqueous, ingenious, sedementary, stratified and unstratified rocks. The work of a mining student is to prepere himself, for the duty of searching for coal, proving faults, dykes, veins, &c., the successful working of coal, but he must have a thorough good knowledge of geology before he can be fully competent. A mining student can by a study of geology compare the rocks of one district with another, as to their position, composition, and the remains of vegetable or animal life, in the form of fossils which the rocks contain. He may determine by these means the probability of any coal, &c., being found, and in these days when new regions are being searched for coal, the value of a knowledge of geology to a mining student cannot be over estimated.

JOHN HY. SENIOR.

ADVANCED.

WATER DAMMED BACK BY COFFERING.

Question 2.—How is water dammed back in shafts by coffering?



Answer.—The following is a description of what is probably the largest application of coffering, the shaft being 20 feet diameter in the clear, the coffering extending about 55 yards (from a depth of 105 to 50 yards below the surface). After passing through the water-bearing beds, the shaft was sunk 20 yards below the point where the last feeder was met and a cast-iron curb put in, supported on iron plugs. Upon this about 26 yards of 14in. brickwork was built, and then the walling was carried up solid for 12 feet, until the water-bearing strata was met with. The object of doing this was to provide some substantial support for the coffering and to prevent any risk of the masonry settling and cracking. It was decided to put in the coffering 2 feet 3 inches thick. Some means had to be adopted to carry off the water running from the rocks and prevent it passing over the brickwork and washing the mortar joints away. To do this, "plug boxes" were bedded on the solid work. Six of these were placed at equal intervals around the circumference, and were formed of wood, 12 inches square by 2 feet 9 inches long, having a hole 3 inches diameter bored along their longer axis to within 2 inches of the back (A), and then a vertical hole (B) bored from the top to meet the horizontal one. In this latter, vertical wooden pipes with horizontal openings were carried up behind the brickwork and allowed the water to pass away through the openings in the plug boxes. The holes in the water-troughs were bored at vertical intervals of 3 inches. As the brickwork and puddle reached each hole it was plugged up and the water conveyed away through the next higher one. The solid walling was then brought up level with the top of the plug boxes and the coffering commenced. This consisted of five rings of brickwork; the special feature of this system being that the joints are broken vertically and horizontally. Header courses are not employed, stretchers only being used. To commence with the first ring (C), which is of ordinary brick, is 3 ins. thick. The second ring (D) for the first course is laid with bricks 1½ inch thick. The third and fifth rings (E, G) are similar to the first one; while the fourth ring (F) for the first course is also made with 1½ inch brick. Afterwards ordinary bricks, 3 inches thick, are used in all the rings, so that the horizontal joints of the second and fourth courses throughout the work are the thickness of half-a-brick below the others. The method of laying the bricks is the usual one for the first, third, and fifth courses, and when these are in position the spaces between are filled with thin liquid cement, and the second and fourth rows are laid by dropping the bricks into the mixture reposing in the gullet; these are called "floating courses." After getting up about 12 or 18 inches, the space between the back of the brickwork and the strata is filled in with good loamy soil, which must be free from pebbles and should be well and carefully rammed, no spaces being left. The mortar used for the first, third, and fifth rings was a mixture of lime, cement and ashes, well ground in a mortar mill; for the intermediate rings pure Portland cement was employed. WILLIAM SUTHERLAND.

METHOD OF SPRAGGING.

Question 3.—How would you support the coal while holing in dirt, 18 inches thick, in a mine 4 feet thick, working longwall upbrow, rising 1 in 5. What distance apart should the supports be set?

Answer.—The sprags should be set six feet apart, tightened by a wedge at the foot. Midway between the sprags cocker-megs should be set as an extra precaution. (See sketch, page 283, vol. I.)

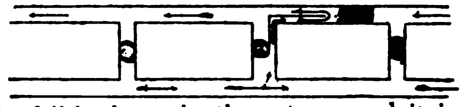
WILLIAM SUTHERLAND.

FIRST-CLASS.

VENTILATION.

Question 4.—If the return airway of a fiery mine was completely blocked up by a fall, how would you proceed ?

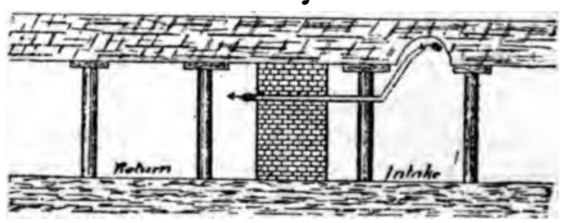
Answer.—The procedure under the circumstances stated in the question will be rather difficult to determine. The question asserts that the return airway of a fiery mine has been completely blocked by a fall. This of course renders the mine unsafe. Hence the first important item to be dealt with is the safety of all concerned. It will be necessary to comply with the C.M.R.A., Section 49, General Rule 7, with regard to dangerous places; the Act states that if at any time it is found by the person for the time being in charge of the mine, or any part thereof, that by reason of inflammable gases prevailing in the mine, or that part thereof, *or of any cause whatever,* the mine or that part is dangerous, every workman shall be withdrawn from the mine or part so found dangerous, and a competent person appointed for the purpose shall inspect the mine or part so found dangerous, and if the danger arises from inflammable gas, shall inspect the mine or part with a locked safety lamp. He shall also make a true report of the condition of the mine or part, etc. After the workmen have all been removed, a competent person (as per Act) should inspect the fall and the contiguous places thereto, and determine the mode to be adopted in the removing of the fall. As the fall has completely blocked the return airway, the workings on the inbye side will no doubt be fouled with gas. The removal of the fall will be attended with danger arising from the gas, which will no doubt be present in large quantities owing to the suspension of the ventilation. Hence it will be requisite to have a sufficient supply of ventilation for the men working at the fall, so as to dilute and render harmless the noxious gases which are present; also it will be necessary (so as to ensure safety) to have a supply of fresh air to mix with the gas which will pour forth out of the inbye workings after the partial removal of the fall. To manage this the following plan may be adopted:—Supposing the workings to somewhat resemble the figure.



The fall is shown in the return, and it is at this point we require sufficient ventilation for the purposes which have arisen from the retarding or suspension of the ventilation. To manage this it will be necessary to broach the stopping as shown, so as to procure fresh air, and also, if necessary, to tram the debris away. The air may be directed from this point to the fall by means of air-pipes, air-boxes, or bratticing, &c., the quantity being regulated at the stopping. If the mine is very fiery the work should be proceeded with, under the supervision of a competent person who has a practical knowledge of the workings, &c. After the fall has been partially removed, there will no doubt be an outrush of gas from the inner workings, this may be diluted by the fresh air which has been brought direct from the main intake. But of course we have been assuming certain conditions. Occurrences of this type can only be efficiently managed by a knowledge of surrounding circumstances.

MYLES BROWN.

Question 5.—How would you prevent the accumulation of gas in a high cavity in the roof of a main roadway ? Give sketch.



Answer.—The method adopted for preventing accumulation of gas in a high cavity in the roof of a main roadway would depend on local conditions, such as the height of the cavity, its position with regard to the return, and the quantity of gas issuing. Supposing the position of the cavity to be in the main roadway, which is also used as the intake, and that there is a large quantity of gas issuing from the strata, the method which may be adopted under these circumstances is shown by the illustration. It will be noted that a pipe with its outer end or orifice, near the top of the cavity, passes through a stopping into the return. The gas is prevented from accumulating by being conveyed away by means of this pipe. The air at the intake side rises up in the cavity and forces the gas through the pipe into the return. This current or motion of the air is produced by the difference of pressure between the return and intake. This method is one of the best for removing accumulations of gas under the foregoing circumstances.

MYLES BROWN.

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No 13. Vol. III. SATURDAY, MAY 18, 1895. FORTNIGHTL[Y] ONE PENNY.

CONTENTS.

EASY LESSONS ON

MINE VENTILATION.

By J. CARTER, First-Class Certificated Manager.

(COMMENCED IN NO. 9, VOL. III.)

MECHANICAL VENTILATION.

OF late mechanical ventilation is rapidly gaining ground, because not only is it the safest, but in point of economy "furnace ventilation" cannot compete with it, as the cost per horse-power per hour, as shown by the late Mr. Morrison, with furnaces varied from the third of a penny to three-pence half-penny, and the working cost with fans was only half a farthing. See Transaction of North of England Institute of Engineers, Vol. XIX.

Numerous other examples might be quoted, but I will only give the following, which is the descripton of a fan at Dairy Pit, Wigan, by Mr. C. Cockson, Manchester Geological Society, XVII, 231.

Previous to the erection of the fan there were two furnaces underground, having a fire-grate area of 129 square feet, on which 12 tons 17 cwt. of Arley mine mixture were burnt in 24 hours, producing, when the furnaces were very hard fired, 142,570 cubic feet of air per minute. Besides this, it cost for wages 19s. 3d., for fuel £4 3s. 7d., being a total cost of £5 2s. 10d. per 24 hours, so that the cost for twelve months would equal (365 × £5 2s. 10d.) £1876 per annum. The fan which had to supersede the furnaces gave the same quantity of air as the furnaces when running at 52 revolutions per minute, burning 4 tons 2 cwt. of rough buzzard slack per 24 hours, and costing for wages 10s. 6d., and 15s. 4d. for fuel, making the total cost per 24 hours £1 5s. 10d. This multiplied by 365 days gives a cost of £471 per annum, which shows a saving (by the use of the fan) on the two items, labour and fuel, of £1405 per annum. From this amount an allowance for stores, depreciation, etc., would have to be made, after which a good substantial balance would be left. Hence it is generally claimed that mechanical ventilation is far superior to furnace ventilation, being cheaper, more under control, more efficient, and if required, can easily be varied according to the circumstances.

There are two classes of fans, viz.:—The forcing fan, which forces the air into the mine; and the exhaust fan, which exhausts the air from the mine. The latter class is chiefly used. Of course, there is a great variety of exhaust fans, each inventor claiming some particular advantage of his own. It is not my intention here to recommend any special fan but to give information on work produced by some fans.

The following table was issued some time back by the makers of the Guibal fan (which is a favourite mechanical ventilator with many engineers), to represent practically the duty of the various dimensions at a fair

working speed. This would, of course, vary naturally with the conditions of the shafts and airways of the mines:—

Dia. of V'tilator.	Width of V'tilator.	Vol. of Air per min.	Water Guage.	Suitable Engine-power. Dia. Cyl.	Stroke.
ft.	ft. ins.	cu. ft.	ins.	ins.	ins.
10	4 0	20,000	0·50	6	12
12	4 0	30,000	0·65	12	12
16	5 6	40,000	0·80	12	18
20	6 6	50,000	1·20	18	18
24	8 0	70,000	2·00	20	20
30	10 0	100,000	2·75	24	24
36	12 0	150,000	3·50	30	33
40	12 0	200,000	4·25	36	36

Before entering into the calculations on mine ventilation and the laws which govern such, I will give a few explanations of some of the terms used in the subject of ventilation and will divide them into two classes, viz.:—1st. Terms used in coursing ventilation round the workings of a mine. 2nd. Terms used in relation to the laws of mine ventilation.

TERMS USED IN COURSING VENTILATION THROUGH THE MINE.

AIR PIPES.—The tubes or boxes for air to pass through, and are used to ventilate a single road underground, because by their use we form both an intake and return.

AIR-CROSSING.—A place in the mine where one current of air passes over the other. The general plan is to pass the return over the intake. There are several methods of construction, but they are generally made by building walls of great strength on each side of the lower road (so as to withstand a great amount of force to prevent damage in case of explosion) and planks laid across from one side to the other, making them airtight. Masonry may be used and arched over, and sometimes boiler tubing is employed to form an air-crossing (fig. 1). A good plan is to have a road driven in the solid, leaving a few yards of rock between the intake road and return. The construction shown in plan and section by fig. 2 forms one of the strongest kinds of air-crossing.

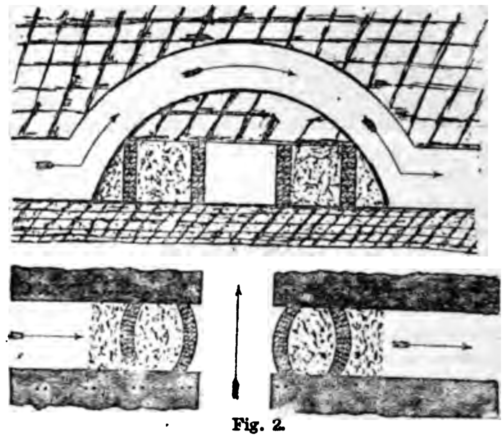


Fig. 2.

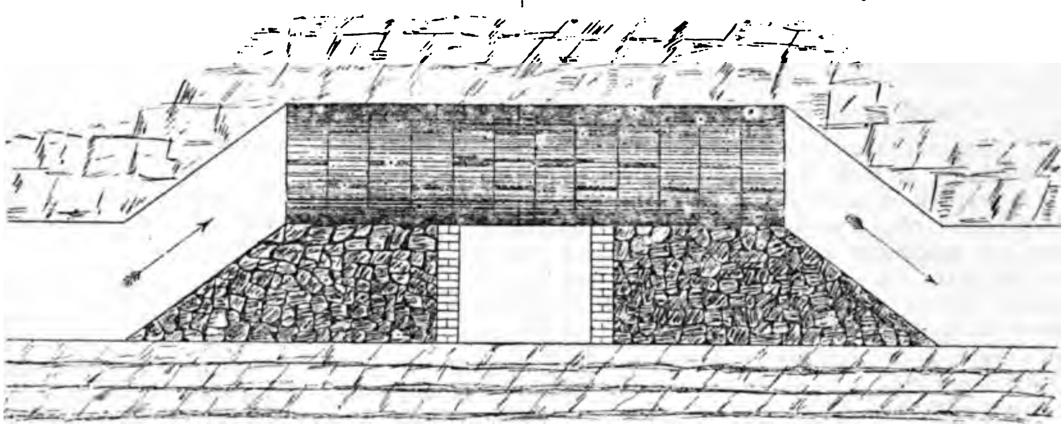


Fig. 1.

AIR COURSE.—A road constructed and kept open for the passage of air underground.

DUMB-DRIFT.—This is a road driven at such an angle from the return airway into the upcast shaft as to enter the shaft a sufficient distance above the furnace to prevent the return air from exploding at the furnace should it be at any time inflammable.

DOWNCAST.—The shaft through which the fresh air enters and passes down into the mine.

UPCAST.—The shaft through which the return air of the mine ascends.

STOPPINGS.—In coursing the ventilation round the workings of a mine, openings in

the mine between the intake and return have to be built up. This is usually done by building a brick wall across the intake end of the opening; and to ensure its being air-tight the return side is packed with dirt.

DOORS.—Occasionally in main travelling roads, doors have to be used to prevent the air from going along them, while it enables persons to travel and boxes to pass through during work, without interrupting the ventilation, because they are chiefly erected in pairs, so that one can be shut while the other is open. A door placed in a frame erected for the purpose, made to open in one direction against the current, is termed a main door. Doors placed between the upcast shaft and the downcast are termed separation doors, and are frequently set up in twos and threes. Doors are sometimes placed in an opening between intake and return, about 18 inches to 20 inches square (usually supplied with a lock and key) to allow officials to pass through or persons who have to look after repairs in the airway.

BRATTICE.—A partition in an underground road to divide it into two parts, intake and return. Air goes along one side and returns on the other, as in cases from the last opening cut through (in opening mines) until another opening further on is made. In some parts thin deal is used for this purpose, but but in a great many districts sheeting, called brattice cloth, is used. Sometimes tubes of iron or wood are used for dividing the air channels.

REGULATOR.—A door (fig. 3), the opening of which can be so arranged that the quantity of air passing through can be regulated so as to send a sufficient supply through the district and no more. Air if not checked will always take the shortest path, or the road where the least resistance is to be met with, hence the necessity for so regulating short splits or roads to the return or upcast. In mines it is not always possible to arrange the size of the splits so as to be equal, and even if this were possible, how often is it required in some districts to have a greater amount of ventilation than in others? A man in charge of a mine knows that this is frequently the case, because of the numerous difficulties which arise in some districts more than others, and the only resource at his command at times is to reduce the quantity in some of the other districts by means of regulators.

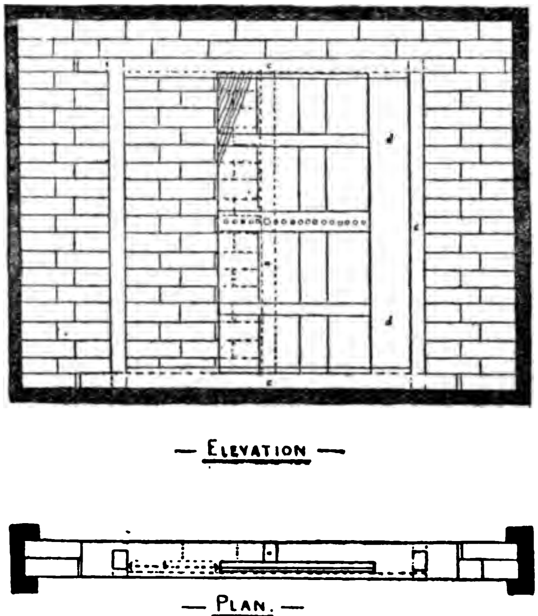


Fig. 3.

TERMS USED IN VENTILATION CALCULATIONS.

AREA.—The superficial measurement of anything, for instance, a roadway in the mine, the area of which is obtained by multiplying the height by the width. Example: A road measures 8 feet high and 10 feet wide, then the area equals $8 \times 10 = 80$ square feet.

PERIMETER.—The outline or boundary of a figure. For instance, the perimeter of a roadway, 5 feet square, would be 20 feet. The perimeter of a roadway, 7 feet by 6 feet, would be $7 + 7 + 6 + 6 = 26$ feet. Take a circular shaft 12 feet in diameter and find its perimeter, or what is equivalent its circumference. This would be $12 \times 3{\cdot}1416 = 37{\cdot}6992$ feet.

RUBBING SURFACE.—The area of the roof, sides, and floor of the roadway against which the air rubs as it flows along, usually expressed in square feet and is equal to the perimeter × length. Examples: (1) In a roadway, 1500 yards long and 5 feet square, the rubbing surface would be $5 + 5 + 5 + 5 = 20 \times 1500 \times 3 = 90000$ square feet. (2) In a shaft 12 feet diameter and 500 yards deep, the rubbing surface would be $12 \times 3{\cdot}1416 = 37{\cdot}6992 \times 500 \times 3 = 5654{\cdot}88$ square feet.

MOTIVE COLUMN.—A head of air or the length of an air column, generally reckoned in feet, of the same density as the flowing air, equal to the pressure producing ventilation.

Power of Ventilation.—The force at work in moving the air, and may be reckoned in units of work in foot pounds or horse-power, and is obtained by multiplying the pressure by the quantity.

Co-efficient of Friction.—The quantity or number used as a multiple representing the pressure for overcoming the friction of air at a given velocity in rubbing against a given area of surface of a roadway underground in passing along it. The late Mr. Atkinson gives "that for every foot of rubbing surface, and for a velocity in the air of 1000 feet per min., the friction is equal to 0·26881 feet of air column of the same density as the flowing air, which is equal to a pressure, with air at 32°, of 0·0217 lbs. per square foot area of section." Different authorities on ventilation have given different co-efficients of friction, but it is not my intention to discuss which is the most correct but simply to use the above co-efficient throughout the whole of my calculations.

Pressure of Ventilation.—The motive force obtained by the exhaustion of air in the upcast or by rendering the air current of less density at one end than the other, and the flow of air will be in the direction of the lesser weight.

ANSWERS TO CORRESPONDENTS.

J. G. B.—The awards are given to the best *set* of answers in each stage, and it does not follow, because one of your answers was the best, that your set of answers was the best.

T. R.—It is impossible for us to give private lessons, but we are always pleased to help aspiring candidates through the medium of our journal.

Science.—There is no doubt that the subjects you mention would be of the utmost use to our readers, but we cannot set aside mining proper to give space for them, as this is of still greater importance.

T. A.—We cannot pretend to verify all the correspondence we insert. If, however, we chance to see a mistake we withhold the copy. The answer you send in is incorrect; instead of taking the weight of the rope as you worked it out, you have taken another number by mistake.

T. H.—Your writing is very clear and legible, and is good enough not only for a second but for a first-class certificate; we only wish half our correspondents and competitors would write so clear. To your second query we answer, yes in some districts, *e.g.*, Manchester, Liverpool, &c.

J.B.—Particulars of your invention to hand, we will carefully look the matter over and write you our opinion.

J.H.—Thanks for correction.

W.L.—Have written you.

EXAMINATION QUESTIONS ANSWERED.

By a First-Class Certificated Manager.

Questions given at the Manchester Examination for First-Class Certificates of Competency, Dec., 1894.

(Commenced in No. 12, Vol. III.)

III.—Practical Mechanics.

Q. 10.—What quantity of water will be delivered by a double-acting piston pump, 2 feet 8 inches stroke, 9 inches diameter, working at 15 revolutions per minute; the pump rod (on one side of plunger only) being 3in. diameter, and allowing 5 per cent. for slip? (6 marks.)

A.—Area of one side of piston, $9 \times 9 \times \cdot7854 = 63\cdot617$ square inches.

Area of pump rod, $3 \times 3 \times \cdot7854 = 7\cdot068$ square inches.

Area of other side of piston $= 63\cdot617 - 7\cdot068 = 56\cdot549$ square inches.

Quantity of water delivered per double stroke (or per revolution) neglecting slip $= 63\cdot617 + 56\cdot549 = 120\cdot166$ square inches $\times$ 2 feet 8 inches $= \frac{120}{144} \times \frac{8}{3} = \frac{20}{9}$ cubic feet per revolution; allowing 5 % slip the pump will have 95 % or $\frac{95}{100}$ useful effect, and as the number of revolutions = 15 per minute the quantity of water delivered will be $\frac{20}{9} \times \frac{95}{100} \times 15 = \underline{31\frac{2}{3}\text{ cubic feet per minute.}}$

Q. 11.—A winding engine with drum 20 feet diameter, and two cylinders each 30 inches diameter and 5 feet stroke, has during a winding an average effective pressure of 40 lbs. per square inch; the average speed is 40 revolutions per minute. What is the horse-power, the average speed of cage, and speed of piston in feet per minute? (6 marks.)

A.—Area of cyl. $= \frac{30}{12} \times \frac{30}{12} \times \cdot7854 = 4\cdot90$ square feet; 40 lbs. per square inch $= 40 \times 144 = 5760$ lbs. per square foot; work done by each cyl. in one minute of 40 revolutions (1 revolution = 2 strokes) $= 4\cdot9 \times 5760 \times 5 \times 2 \times 40 = 11289600$ foot pounds

$$\therefore \frac{11289600 \times 2}{33000} = \underline{684\cdot2 \text{ H. P. of engine.}}$$

Piston speed per minute $40 \times 5 \times 2 =$ <u>400 feet.</u>

20 feet diameter drum $= 20 \times 3\cdot1416 = 62\cdot832$ feet circumference $\times$ 40 revolutions = <u>2513·28 feet cage speed.</u>

Q. 12.—A crab has a handle 16 in radius and barrel 7 inch in diameter, it is double-geared with pinions 14 and 16 teeth, and wheels of 100 and 120 teeth respectively. What is the mechanical advantage, and what weight could a man lift by means of this crab and a pair of three-sheaved blocks, when exerting a force of 60 lbs. upon the handles, neglecting friction? (6 marks.)

A.—Diameter of crab handle circle $= 16 \times 2 = 32$ inch, $\therefore$ mechanical advantage of crab is

$$\frac{32}{7} \times \frac{100}{14} \times \frac{120}{16} = \frac{12000}{49} = \underline{\underline{244{\cdot}9 \text{ to } 1 \text{ (nearly)}}}.$$

With a pair of three-sheave pulleys for every 6 feet of rope pulled in, the weight is only lifted 1 foot; therefore the mechanical advantage is $\underline{\underline{6 \text{ to } 1}}$.

The weight which a man could lift, exerting a force of 60 lbs. would therefore be

$$244{\cdot}9 \times 6 \times 60 = \underline{\underline{88164 \text{ lbs.}}}$$

Q. 13.—The lever of a safety valve is 36 inches long to the centre of the weight, and $3\frac{1}{2}$ inches from the heel or fulcrum to the valve; the valve is 4 inches diameter and the weight is 70 lbs. What is the pressure per square inch when steam begins to blow off? Weight of lever and valve not to be taken into account. (6 marks.)

Total pressure on valve $\times 3\frac{1}{2} = 36 \times 70$

$\therefore$ valve pressure $= 36 \times 70 \div 3\frac{1}{2} = \underline{\underline{720 \text{ lbs.}}}$

Valve is 4 inches diameter $= 4 \times 4 \times {\cdot}7854 = 12{\cdot}5664$ sq. in. area, $\therefore 720 \div 12{\cdot}5664 =$ $\underline{\underline{57{\cdot}29 \text{ lbs. per square inch.}}}$

IV.—Practical Working.

Q. 14.—State what you know about the explosive properties of coal dust, and what precautions you would take in working a dry and dusty mine? (6 marks.)

A.—Comparatively recent experiments and calamities tend to prove that coal dust is almost as dangerous as large accumulations of fire-damp by reason of its explosive properties. Coal dust in an atmosphere containing $\frac{1}{2}$ % of CH_4 has been demonstrated to be highly explosive, whereas it requires more than 7 % of CH_4 alone to become explosive. Whether coal dust alone is sufficient to cause an explosion or not is still an open question, but that the presence of CH_4 is unnecessary has been shown by numerous experiments. Accumulations of coal dust have been fired by explosive shots, but some argue that the very gases given off by the explosive have been the means of firing the coal dust, and that the coal dust would not be explosive were it not for the presence of these gases. That carbon mon-oxide does materially assist coal dust in exploding the writer has had sufficient proof to show, and as many explosives give off large quantities of this gas, it may be the source of many explosions. I would take the same precaution as if working a fiery mine, none but a good type of safety lamps should be used, and no shots should be fired except when the men are out of the mine. Accumulations of dust should be removed as far as practical, and a thorough system of jet spray watering should be adopted. The deputies should be provided with delicate gas-testing lamps, so that the presence of small percentages of gas could be recorded.

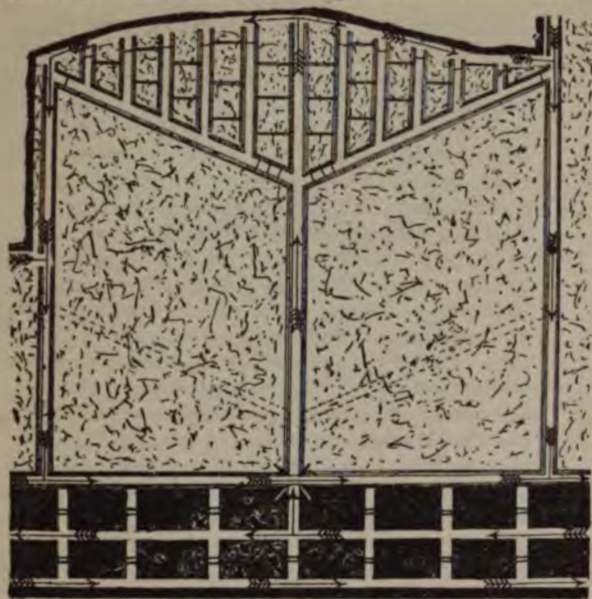
Q. 15.—Describe the means you would adopt to secure wire guides (or conductors) to the head-gear, and your arrangements for keeping the guides sufficiently rigid? (6 marks.)

A.—I would *cap* the rope at the top to a eye-bolt which would be secured to the head-gear. The rope should be also capped at the bottom and kept taut by weights.

(For details of this answer see Engineering of Collieries, by T. A. O'Donahue, last issue.)

Q. 16. Make a sketch of some method of coal working with which you are familiar, showing a main heading, and at least four working places. Show the drawing roads, packs, timbering, and mode of ventilation. (6 marks.)

A.—The sketch shows a method of working a 4 feet seam of coal with which I am acquainted. Three levels or main headings are driven out on each side of the pits, and longwall workings are commenced on the higher side of the levels. The seam is worked in districts, each district comprising a face of coal of about 200 yards in length working to the rise. A main brow or self-acting jig road is left along the centre of each district, and slants are commenced from this brow about every hundred yards, so as to cut off the long lengths of drawing roads. The roof stone is ripped down in the drawing road and packed into walls on each side of about 8 feet thick, and the colliers leave pack walls behind them about every ten yards. Two or three rows



of props are fixed at the face to support the roof, with chocks at intervals of a few yards were required. For sketch shewing section of face, see page 190, No. 16, Vol. I.

(*To be continued.*)

CORRECTION.

In the answer to Question 1, last issue, the water gauge was taken in the calculations as 2¼ instead of 2½.

CORRESPONDENCE.

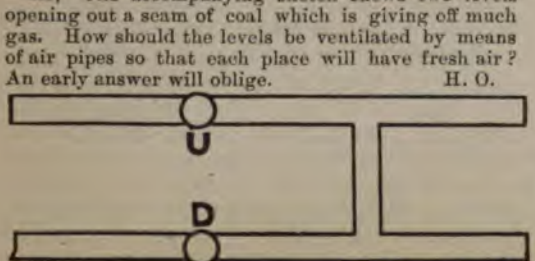
We will publish a reasonable amount of correspondence per issue, but subject to the following conditions:—

To be written on one side of the paper only.
Envelopes to be marked "Correspondence."
Name and address of sender must accompany such correspondence as a sign of good faith, but the writer may assume a *Nom-de-plume* to be published if he so desires.
Correspondence must not be enclosed with Competition Answers.

The Editor will not hold himself responsible for any correspondence, nor will the publishing of it affirm that we hold the same views as the writer.

PRACTICAL VENTILATION.

Sir,—The accompanying sketch shews two levels opening out a seam of coal which is giving off much gas. How should the levels be ventilated by means of air pipes so that each place will have fresh air? An early answer will oblige. H. O.



C. M. R. A. & CERTIFICATES OF SERVICE.

Sir,—In reply to "Howker"—If the overman had five years' experience, and acted as overman before the passing of the Act and since that date, or at any time within five years before the passing of the Act, for a period of not less than twelve months, then the claim for the certificate was valid. If, however, the certificate was obtained by misrepresentation it may be taken from him, and the person who made the false statements is liable, on conviction, to imprisonment. NOVICE.

CONGRATULATORY LETTERS.

Sir.—I am pleased to inform you that at the recent examination for colliery managers' Certificates, South Wales centre, held at Cardiff, I successfully passed for my first-class certificate, which is very gratifying to me seeing that I am a practical workman and self-taught. I may say I have received valuable aid from your little journal which I think is the best pennyworth of information that can be got. I shall continue to subscribe to it, and I trust its future will be a bright and prosperous one. WM. SLOCOMBE.

Sir,—I have received the postal order which you sent, being the award given for the elementary answers, which I prize very much, not for the mere value but because it is the first award of any kind I have ever received on the subject of mining. It was reading your valuable journal which prompted me to enter the competition in order to test my knowledge. Since I entered the competition I am very pleased to say that my knowledge on mining matters has improved very much as has also my handwriting. If miners would only take more interest in your journal we should have less accidents in our mines, the cause of which is neglect and want of knowledge of the principles of mining. Allow me then to wish your valuable paper every success. THOMAS WEBSTER.

ANSWER TO VENTILATION QUERY.

Sir,—In reply to "Anxious," I offer the following solution:—If 80,000 cubic feet of air is split into three airways of different lengths, but equal areas, A being 2,000, B 4,000, and C 6,000 yards long. What quantity will pass into each. The quantity that will pass into each will be inversely as the square root of the resistance (*i.e.*, the length), and their proportion will be as follows:—$\sqrt{\frac{1}{2000}} = \cdot 02236$ for A, $\sqrt{\frac{1}{4000}} = \cdot 0158$ for B, and $\sqrt{\frac{1}{6000}} = \cdot 0129$ for C, $\cdot 0156 + \cdot 0129 = \cdot 05106$. And as the whole is equal to its parts, so is the total quantity to the quantity passing into each airway.

$\therefore \cdot 05106 : \cdot 02236 :: 80000 : 35034 =$ Q passing into A
$\cdot 05106 : \cdot 0158 :: 80000 : 24755 =$ " " B
$\cdot 05106 : \cdot 0129 :: 80000 : 20211 =$ " " C
$35034 + 24755 + 20211 = 80000$ total quantity.

F. G.

(Somewhat similar answer sent by J. Gray.—ED.)

Correction.

Sir,—You will find that there is a mistake in the answer on ventilation given by T. Arnot. You have got $\frac{100 \times 2 \cdot 1}{100}$ and it should be $\frac{100 \times 21}{64} = 3 \cdot 281$.

F.G.

[The question was worked out correctly, the error being the printer's not the correspondent's.—Ed.]

COMPETITION QUESTIONS.

No. 16 SET.

To the sender of the best set of Original Answers in each Stage will be awarded the following:—

Elementary 2s. 6d., Advanced 3s. 6d., First-Class 4s. 6d.

A Competitor may only answer one Stage. The best answer to each question will be published with the sender's name and address.

1.—All envelopes must be marked "Competition."

2.—To be written on separate sheets of paper with name attached, and on one side of the paper only. Sketches to be in ink (Indian ink preferred) on *unruled* paper.

3.—Correct name and postal address must be sent.

4.—They must reach us by May 31st, 1895.

5.—The Editor's decision as to winners to be final.

ELEMENTARY.

Question 1.—Describe the pillar and stall method of working coal in two modifications. Give sketches.

ADVANCED.

Question 2.—What gases are likely to be found in the air of coal and metal mines respectively?

Question 3.—Describe in detail a method of longwall working suitable for a 4-feet coal with a dip of 1 in 6, showing the best method of securing the face. Give sketches.

FIRST-CLASS.

Question 4.—With a winding shaft 500 yards deep with two cages working in it on weighted conductors. Describe a test by which you can ascertain (without an inspection of the weights in the dib-hole) that such weights are hanging free and clear, and are in working order

Question 5.—In sinking a shaft how would you protect the bottom bricking ring from damage by shots when proceeding with sinking after bricking up? Give sketch.

EXAMINATION QUESTIONS.

(*South-Western District, September, 1894.*)

The figures in parenthesis show the number of marks obtainable for each question.

Managers' Certificates of Competency.

No. 1. Subject—*Arithmetic.* (60 marks to qualify.

1. Multiply $\frac{5}{7}$ of $\frac{3}{11}$ of $\frac{1}{35}$ by $\frac{9}{11}$; and divide $\frac{9}{11}$ by $\frac{1}{3}$ of $\frac{9}{15}$. (20)

2. By drawing 453·75 gallons of water from a square tank, the surface of the water falls $\frac{9}{10}$ in. What is the inside measurement of one side of the tank? (20)

3. According to a colliery cost-sheet coal is delivered at the pit bank at a cost of 5s. 0·77d. per ton. What would be the respective costs at—(1) an advance of $13\frac{1}{4}$ per cent.?; (2) a reduction of $6\frac{3}{4}$ per cent. (10)

4. If the average cost of sinking a shaft to a depth of 540 yards will amount to £18 per yard, and 23 per cent. of the strata sunk through will cost 45 per cent. more than the average cost, what will be the average cost per yard for sinking the remaining 77 per cent.? (20)

5. The circular upcast shaft of a colliery is 20 ft. in diameter, and the air-current passes through it at a mean velocity of 13 ft. per second, being supplied by four returns, as follows:—No 1 return has an area of 100 ft., and the mean velocity of the air current is 10 ft. per second. No. 2 return has an area of 80 ft., and the mean velocity of the air-current is 12 ft. per second. The areas of Nos. 3 and 4 returns are each 70 ft. What will be the mean velocity per second of the air-currents in Nos. 3 and 4 returns respectively, assuming that the quantities of air passing through them are in the proportion of 45 to 55? (30)

No. 2. Subject—*Surveying.* (60 marks to qualify.)

1. Make a sketch of a vernier, and explain its use when fitted to instruments. (20)

2. By means of instruments provided, plot the following survey to a scale of 2 chains to an inch:—

	Links.
S. 11 degs. W.	420
S. 40 degs. E.	350
N. 10 degs. E.	600 (20)

3. Describe any form of miner's dial you are acquainted with, pointing out the advantages you have experienced by the use of it underground. (10)

4. Work out the quantity of coal contained in 1 acre of a seam of the following section:—

	Ft.	in.
Top coal	2	3
Clod	0	11
Bottom coal	2	9

Specific gravity of coal, 1·25. (25)

5. Work out the horizontal base and the vertical height of an inclined plane, 26·65 chains long, which rises 1 in 4. (30)

No. 3 Subject—*Gases and Ventilation.* (110 marks to qualify.)

1. Name the principal gases met with in coal mines and the gases composing the atmosphere, giving the chemical symbol and the specific gravity of each gas. (10)
2. Describe the water-gauge and its utility in mining. (20)
3. In a heading 7ft. 6in. x 6ft. 8in. the air travels 40 yards in 12 seconds under a pressure of 2·5 in. w.g. What is the effective horse-power of the ventilation? (20)
4. A return air-current of 10,000 cubic feet per minute contains explosive gas in the proportion of 1 of firedamp to 13 of air. What is the least volume of air per minute which must be added to the current to prevent its showing a "cap"? (20)
5. State the provisions of the Coal Mines Regulation Act of 1887, with regard to ventilation. (20)
6. What would be the percentage of change in the volume of gases in goaves owing to a fall of the barometer from 30 to 29in.? (20)
7. Indicate on the accompanying plan how you would ventilate the workings there shown in a manner suitable for working a fiery seam. (30)
8. The water-gauge at the fan drift of a colliery stands at 2in. when the quantity of air passing is found to be 150,000 cubic feet per minute. What quantity would you expect to pass with the same expenditure of ventilating power, if the water-gauge rose to 2·5in. owing to increased resistances in the airways? (20)

No. 4. Subject—*Practical Mining and Geology.* (100 marks to qualify.)

1. Describe the provisions of the Coal Mines Regulation Act of 1887 with regard to dangerous practices not expressly prohibited. (20)
2. Draw a section of the seam, floor and roofs, with which you are best acquainted, at any colliery, and illustrate with sketches how the seam is worked at the face. (20)
3. Describe the duties of a colliery manager, as laid down in the Coal Mines Regulation Act of 1887. (20)
4. Several shots have to be fired in a dusty and fiery mine. What precautions should be observed by the shotfirer? (20)
5. Explain the action of the syphon, and give an example of its application to mining. (20)
6. In proving a fault in a coalseam, what operations would you carry out in order to win the coal? Illustrate your answer by a sketch or sketches. (20)
7. Describe the properties of anthracite, bituminous, semi-bituminous, cannel coals, and lignite. (20)
8. Describe in their order the sub-divisions of the carboniferous system, and their chief characteristics in Great Britain. (20)

No. 5. Subject—*Colliery Plant and Machinery.* (60 marks to qualify.)

1. The valve motion of a non-reversing horizontal engine is found to be out of adjustment owing to the eccentric having become loose on the shaft, and to the valve having shifted in on the rod. Explain how you would proceed in order to fix the eccentric and valve in their proper positions. (20)
2. Sketch the best form of metallic piston your are acquainted with, and describe it. (20)
3. Sketch a safety valve suitable for a steam boiler. (20)
4. How would you guard against danger from sparks emitted from the brakes of underground hauling engines. (20)
5. If the breaking strain of a wire rope is 22 tons what would be its safe working load for winding out of a colliery shaft? (20)
6. What are the provisions of the Coal Mines Regulation Act of 1887 regarding the inspection of colliery machinery and appliances? (20)

Under-Managers' Certificates of Competency.

No. 1. Subject—*Arithmetic.* (60 marks to qualify.)

1. A pillar of coal weighs 7 tons 16 cwt. 17 lb. What is its weight in pounds? (10)
2. If an adit or heading rises 16 ft. in a total length of 768 yards, what is the rise per yard? (10)
3. 1 cwt. of steel hammers cost £1 7s. 4d. and they weigh 7 lbs. each. What is the cost of each hammer? (10)

4. How many revolutions per minute must be made by a drum of 4ft. diameter to give a speed of 6 miles an hour to the rope? (30)

5. Three men, A, B, and C, worked at the same rate of wages, and earned a total sum of £3 17s. 7d. A worked $3\frac{1}{2}$ days, B worked $4\frac{1}{2}$ days, C worked 6 days. How much money did each man earn? (20)

6. If you pay a 1d. per inch thick per yard forward for ripping top 6 ft. wide, how much per cubic foot does the ripping cost? (20)

7. A stall turns out 30 tons per week, and deadwork is as follows:—3 sets of timber at 1s. 6d. each; 2 cogs at 11d. each; 3 yards of ripping top at 2s. 9d. per yard; 3 yards of cutting bottom at 9d. per yard; and 4 trams of rubbish at $2\frac{1}{2}$d. per tram. How much does the deadwork cost per ton of coal? (20)

No. 2. Subject—*Ventilation.* (60 marks to qualify.)

1. What quantity of air passes per minute through an air-way 6 ft. high and 8 feet wide when the velocity or speed of the air-current is $6\frac{1}{2}$ ft. per second? (20)

2. Describe the barometer and explain its use? (20)

3. Describe a good safety lamp for the use of colliers in fiery mines. (20)

4. How would you satisfy yourself that the ventilation is adequate in a naked light mine? (20)

5. What effect has carbonic acid gas, or blackdamp, on mixtures of firedamp and air? (20)

6. Would you expect the air of a mine to contain most moisture in warm weather or in cold weather? State your reasons. (20)

No. 3. Subject—*Practical Mining.* (120 marks to qualify.)

1. Sketch a section of a coalseam in your district, and describe the best manner of dealing with the top and bottom in the stall or wagon roads in the seam you refer to. (20)

2. In working the longwall system, what would guide you in deciding the best distance between the stall or wagon roads? (20)

3. Sketch a plan showing how you would open a piece of longwall work in maiden ground, marking the direction of dip and slips, and show by arrows how you would ventilate the workings. (20)

4. If three workable seams of coal occur in water-bearing strata at equal distances apart, and within a depth of 20 yards, in what order would you work the seams, assuming the roofs to be similar in character? State your reasons. (20)

5. In working a seam of coal from the outcrop to the dip, what precautions would you take as a security against being troubled with water? (20)

6. If in examining a district during the working hours of a shift you find a dangerous accumulation of gas, what course would you adopt? (20)

7. What are the requirements of the Coal Mines Regulation Act, 1887, with regard to the employment of youths under 16 years of age? (20)

8. What is a dumb drift? (20)

9. Make a sketch to show the proper positions in which props should be set, and "chocks," or "cogs" should be built in working a seam in steep measures. (20)

10. The percentages of accidents from falls of roofs vary considerably in different collieries, even where the seams of coal worked, the character of roof, and the mode of working are similar. How do you account for the variations? (20)

ANSWERS TO QUESTIONS.

No. 13 Set—In No. 10, Vol. III.

ELEMENTARY.

DIFFERENT COALS AND WHERE FOUND.

Question 1.—What are cannel, hard steam coal, and anthracite, and where are they chiefly found in the United Kingdom?

CANNEL COAL.

Answer.—Cannel coal is a mineral of a black or brownish colour, with a very dull lustre. Its composition on an average consists of about 80% of carbon, 6% of hydrogen, 7% of oxygen, 2% of nitrogen, and 3% of ash. It is very hard and compact, and breaks with a conchoidal or shell-like fracture; it does not soil the fingers when handled, and is capable of being cut and shaped into ornaments. It kindles readily, burns freely and quickly, and is largely used for making gas for illuminating purposes. It is probably of subaqueous origin, as the spines and teeth, etc., of fishes belonging to the Palœoniseus type have been frequently found in it, and it is found in saucer-like layers which thin away at the edges. The word cannel is derived from the word candle, because

it burns with a flame like a candle. Cannel coal is chiefly found in the Lanarkshire coalfield, in Scotland; and in the Lancashire coalfield, in England.

HARD STEAM COAL.

This kind of coal is found in great abundance in the County of Northumberland and also in South Wales. It is of a dull black colour and breaks with a cuboidal fracture. It is one of the non-caking variety, as the cake obtained is brittle and useless for commercial purposes. It is easily recognised by the whole flakes of felspar which are found in its cleat. It is a valuable coal for steam-raising purposes, and its average composition is 80% carbon, 5% hydrogen, 11% oxygen, 1% sulphur, and 3% ash.

ANTHRACITE COAL.

Anthracite is more compact and dense than ordinary coal. It generally has a shining and sometimes semi-metallic lustre, and does not soil the fingers when handled. It burns without smoke or flame, and although it is not so easy to kindle as other coals it evolves intense heat when in a state of perfect combustion. The composition of this coal differs slightly from the ordinary coals, as it contains a greater percentage of carbon and less hydrogen, its average being about 90% of carbon, 3% of hydrogen, the remaining 7% consisting of oxygen, nitrogen, and earthy substances. Anthracite is used for generating steam in the manufacture of zinc, lime and brick kilns, etc., and is found chiefly in South Wales. CORNELIUS HARDY.

ADVANCED.

QUANTITY OF AIR REQUIRED FOR VENTILATION.

Question 2.—What volume of fresh air should be provided per minute for each man, lamp, and horse?

Answer.—To answer the above question we must first comply with the C.M.R.A., General Rule 1, which states that an adequate amount of ventilation should be constantly produced in every mine to dilute and render harmless all noxious gases to such an extent that the working places, shafts, drifts, stables, intakes and returns are in a fit state and safe for men to work and pass therein. I would say that nothing less than a current of pure air sufficient to sweep the whole working places, etc., and the entire expulsion of any gas which would either affect the health of the workmen or cause an explosion. It would be very difficult to draw a fixed line as to how much air would be required in a mine, as it would depend upon circumstances. A great many things must be taken into consideration, namely, depth of shaft, thickness of seam or seams, fiery or non-fiery, extent of workings, and the kind of explosives used (if any). It will be seen at once that the quantity of air required to circulate in a mine far exceeds the requirements of life and the combustion going on in the lamps. The following is considered a fair maximum:—

	MAN OR BOY. cu. ft. per min.	HORSE. cu. ft. per min.	LAMP. cu. ft. per min.
Non-Fiery	100	600	50
Fiery	200 to 300	600	50

But the amount of air is not always regulated by the number of men and horses, because in the "Borinage" district of Belgium, which is probably the most fiery in the world, the practice is to make the amount of air proportionate to the output and to increase the current if exploratory work is proceeding. It is often stated that the amount of air passing should be regulated by the number of men employed. Of course, if the output increases, the number of men generally increases also, but the better plan is to be guided by the output. THOS. E. AITCHISON.

HOW TO MEASURE THE QUANTITY OF AIR.

Question 3.—How is the amount of air passing through the workings of a colliery determined?

Answer.—In order to determine the quantity of air passing the velocity has to be ascertained; this, multiplied by the area in square feet at the point of observation, gives the quantity of cubic feet of air. The velocity may be determined by several methods, such as exploding a quantity of gunpowder. Take an airway of uniform section, say 100 yards in length. At the intake end let a man flash powder. A man at the other end seeing the flash starts a stop-watch, which he stops the instant he smells the smoke; in this way the time it takes the smoke to travel 100 yards is ascertained. Another method is to break a bottle containing a strong smelling spirit, such as sulphuric ether. The sound of a hammer or other signal warns the observer that the spirit has been liberated, and the sense of smell tells him when the spirit arrives and his stop-watch shows the time. At the present day it is the invariable practice to employ what are called anemometers for

measuring the velocity of air currents. There are various kinds of anemometers, such as Dickinson's, Robinson's, Davis's self-lining, Capell-Davis, Casartellis, and the Biram. The kind mostly used is the Biram, which consists of a series of vanes placed obliquely to the axis, like the sails of a windmill. An indicator or counter is placed in the centre. The axis of the vanes carries an endless screw, which is geared into a wheel to which a pointer is connected. The velocity is measured by holding the anemometer in the air current for a certain length of time and noting the number of revolutions. To do this two persons are required, as one man cannot hold a watch, anemometer, and lamp with two hands. In taking the observation the instrument is held out at arm's length for a short time, until the vanes are travelling at full speed, due to the air current. A small button is then pressed and the pointer turns to the speed and is kept there by a locking arrangement. Each instrument being graduated by experiment no allowance has to be made. When taking a measurement it is best to take it, say at the top, bottom, sides, and centre; add all together and divide by 5, this will give the mean velocity. The operator must keep well in to the side, in fact it is best to have a recess cut in both sides of the airway to stand in. Mr. Murgue, however, states that the ratio between the mean velocity and the velocity at any given point in the same section remains constant whatever variations there are in the mean velocity. It is only necessary therefore to find the ratio between the mean velocity and the velocity of air at any convenient point, and, in future, merely measure the velocity at that point. For all ordinary purposes the velocity can be determined by holding the anemometer out at arm's length and moving it slowly over the section of the airway. Example: Say the speed is 1000 feet per minute, and the airway is $10 \times 5 \therefore 10 \times 5 = 50$ feet section, then $50 \times 1000 = 50000$ cu. ft. per minute. THOS. E. AITCHISON.

FIRST-CLASS.

PRECAUTIONARY MEASURES FOR THE PREVENTION OF ACCIDENTS.

Question 4.—What other precautionary measures besides those already in force do you deem necessary for the prevention of accidents in and about mines, taking into consideration all recent information ?

Answer.—We know that many serious accidents occur both above and below ground, resulting from explosions of fire-damp, falls of roof and sides, ropes and chains breaking, explosions of gunpowder, flooding of mines, &c. On the surface from boilers bursting, also at railway sidings at the mine, and other miscellaneous accidents. Now we come to the pith of the question how to reduce these calamities to a minimum. (1) Explosion of fire-damp and coal dust. Where fire-damp is frequently found or in dusty mines, I maintain that all such should be ventilated by means of a fan and not the furnace. The fans should be duplicate, so that in case one breaks down or out of repair, the other may be ready for use; also that the fan should be kept running regularly when the pit is playing or during week ends. (2) The pit should be worked in districts and numbered 1, 2, 3, etc., these having separate intake and return airways to and from each circuit. This would prevent the explosion from spreading through the different districts. (3) All the intake and return airways should be of sufficient size, and they ought to be as nearly equal in proportional area and perimeter as possible, and should always be kept in a good and safe condition. The air-currents properly divided into splits so that the air will not have to travel too far, consequently it will be cooler, purer, and fresh for the workmen to do their work, and safer to pass to and fro. (4) In dry and dusty mines the greatest and safest precaution to be taken in regard to coal dust is never allow it to accumulate on the roadways in large quantities. Also in every dusty mine there should be a thorough systematic mode of watering. We must accept the theory of such noted gentlemen as Faraday, Lyell, Atkinson, Hall, Galloway, Stuart, Dixon, Lewis, etc. Even our own practical experience tells us that coal dust is a dangerous agent, and that a gas explosion in a fiery mine may be intensified and carried on indefinitely by coal dust raised by the explosion itself. (5) The abolition of gunpowder and naked lights. Where it is necessary to use explosives they should be of the non-flameless variety such as Roburite, Securite, etc. (6) That all shots be fired by an electric battery, not German squibs, touch paper, straws, and heated copper-wire. (7) All about the pit bottom to be lighted-up by means of perfect close and safe lamps of the same type as the safety lamps, or by electricity. (8) No lamps to be opened or re-lighted down the pit. (9) A good and reliable kind of safety lamp should be used, such as the Marsaut, Gray's, Meuseler, Evan Thomas, Deflectors, and the Davy-shielded for deputies. (10) Every official such as deputies,

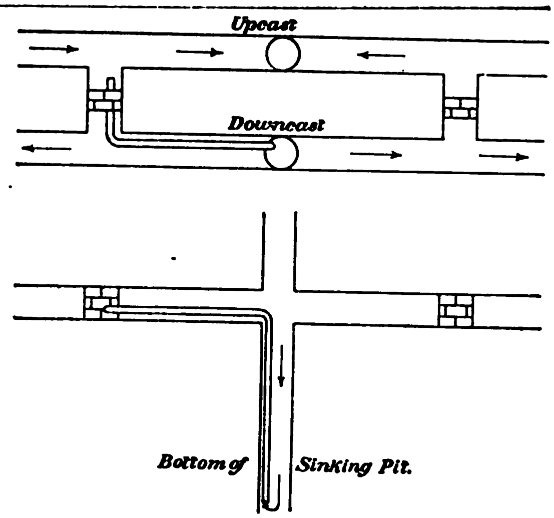
firemen, etc., should pass an examination before being appointed to such place or position. (11) The timbering of mines. To ensure the safety of the workmen it ought to be made compulsory to have timber set, regardless of the apparent nature of the roof or sides. I do not mean that it requires the same amount in good as in bad ground, yet as a safeguard to the miner it is requisite at all times, because most accidents occur in mines having a strong roof, this resulting from the advantage taken and not using due precaution. (12) In driving towards old workings (General Rule 13), what poor statements we have to rely on in using old plans, etc. Even if the full requirements of this rule are carried out, some of the old workings may be driven cross-cuts, or even so narrow that they might be very easily mistaken for a front hole or a flank-hole. Such a case having once occurred. To avoid this I beg to suggest having two drifts instead of one with two front bore-holes, and two sets of flank bore-holes making angles of 30° and 90° with the direction of the drifts. (13) I am strongly convinced that all enginemen and boilermen should possess a certificate of competency before being engaged. It is surprising how many enginemen and boilermen are in charge of such costly machinery, who cannot explain the one-hundreth part of the workings and fittings and also their use. An engineman as well as the boilerman ought to understand all the movements of his engine or boiler, and also thoroughly understand the various laws relating to the expansion and contraction of gases, etc., including Boyle's and Charles. (14) In removing wagons, men only should be allowed at such work on all our colliery sidings. If the above suggestions would be carried into force and adopted at every colliery, such accidents would be reduced to a minimum.

SAMUEL DAVIES.

THE VENTILATION OF A SINKING SHAFT.

Question 5.—How would you ventilate the bottom of a downcast shaft which is being sunk deeper from one seam already working? Give sketch.

Answer.—The method adopted in ventilating the sinking would depend on the mode of procedure taken to deepen the shaft. Supposing the method adopted in sinking is that as shown by the sketch, it would be best to convey fresh air direct from the sinking to



the upcast by the use of air pipes. This method is preferable as a larger quantity would circulate to the sinking and the air would be fresh and pure. It would be best to avoid the use of the return air if convenient. But, of course, it will be impossible to determine perfectly the method to be adopted, as it will depend on local conditions. Yet, if possible, the air should be brought direct from the sinking to the upcast.

MYLES BROWN.

AWARDS

FOR ANSWERS TO COMPETITION QUESTIONS—No. 1?.

ELEMENTARY—Cornelius Hardy, 87, Bestwood Colliery, Nottingham.

Commended—J. H. Hutchinson, R. Brown, T. A. Brown, J. Coates, T. Webster, J. Wheatcroft, J. Roberts.

ADVANCED—T. E. Aitchison, Green Hill, Dunaskin, Ayrshire.

Commended—G. Bell, H. Hall, W. Vickers, C. Barrow, T. Rimmer, J. Crone, A. Swan, J. Wallwork, T. Lawrenson, W. Sutherland, D. Morgan, J. Stephenson.

FIRST-CLASS—S. Davies, Park Road View, Worsbro' Bridge, near Barnsley.

Commended—M. Brown. J. Harrison, J. McPhail, A. Alderson, G. Daykin, J. Davies, W. Slocombe, G. A. Hawes.

COLLIERY MANAGERS' EXAMINATIONS.—Six of the successful candidates in the First Class Exam., and twenty-one of those in the Second Class Exam., held at Cardiff, in April; and two successful in the First Class and nine in the Second Class at Newcastle-on Tyne in January, are students of the Universal Mining School, Derby, conducted by Mr. T. A. Southern, late H.M. Inspector of Mines.

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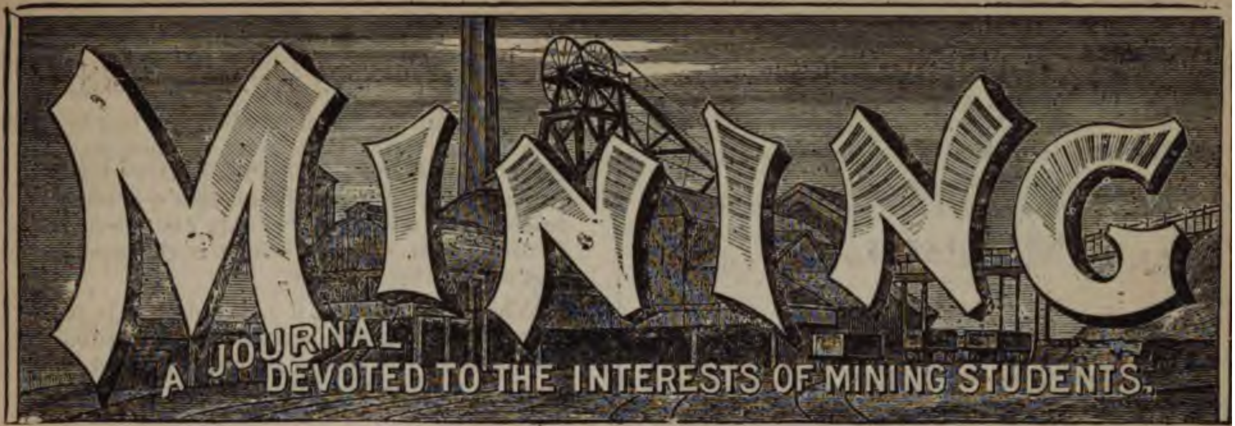


No 14. Vol. III. SATURDAY, JUNE 1, 1895. FORTNIGHTLY ONE PENNY.

CONTENTS.

EASY LESSONS ON

MINE VENTILATION.

By J. CARTER, First-Class Certificated Manager.

(Commenced in No. 9, Vol. III.)

IT is now requisite before proceeding further to explain the various symbols and some of the formulæ used in making calculations on ventilation:—

P = Pressure per square foot.
A = Square feet of sectional area.
S = The area of rubbing surface exposed to the air.
V = The velocity of the air in thousands of feet per minute. (1000 feet per min. is taken as the unit of velocity.)
K = Co-efficient of friction.
V^2 = Velocity in thousands of feet per minute squared.
U = Units of work.
W.G. = Water-gauge.
H.P. = Horse-power.
Q = Quantity of air in cubic feet per minute.

In respect to friction of air in mines the following rules are used:—

(1) $PA = KSV^2$ (2) $P = \frac{KSV^2}{A}$

(3) $A = \frac{KSV^2}{P}$ (4) $K = \frac{PA}{SV^2}$

(5) $S = \frac{PA}{KV^2}$ (6) $V^2 = \frac{PA}{KS}$

(7) $\text{H.P.} = \frac{P \times Q}{33000}$ or $= \frac{PAV}{33000}$

(8) $Q = \frac{\text{H.P.} \times 33000}{P}$

(9) $P = \frac{\text{H.P.} \times 33000}{Q}$

(10) $\text{W.G.} = \frac{P}{5{\cdot}2}$ (11) $P = \text{W.G.} \times 5{\cdot}2$

To some of our readers I have no doubt the above letters may be difficult to understand, for instance, one may ask, what am I to understand by PA or KSV^2 as there are no signs between the letters to denote the procedure? However, when letters are put as above it means (although not expressed but understood) that they are to be multiplied by each other, $PA = P \times A$, and $KSV^2 = K \times S \times V^2$.

Now, in order that our younger students may learn to understand the above, I will endeavour to demonstrate it clearly to them by giving each letter a numerical value, and this will enable such students to easily test them for themselves with very little calculation. These trials should be made until they are thoroughly understood, because in after calculations it will save much time and trouble.

Take the following as representing the values of the letters expressed:—

$P = 4 \quad A = 10 \quad K = 1 \quad S = 8 \quad V^2 = 5$

(1) $PA = KVV^2 \therefore 4 \times 10 = 1 \times 8 \times 5$

(2) $P = \frac{KSV^2}{A} = \frac{1 \times 8 \times 5}{10} = \frac{40}{10} = 4$ value of P

(3) $A = \frac{KSV^2}{P} = \frac{1 \times 8 \times 5}{4} = \frac{40}{4} = 10$ val. of A

(4) $K = \frac{PA}{SV^2} = \frac{4 \times 10}{8 \times 5} = \frac{40}{40} = 1$ val. of K

(5) $S = \frac{PA}{KV^2} = \frac{4 \times 10}{1 \times 5} = \frac{40}{5} = 8$ val. of S

(6) $V^2 = \frac{PA}{KS} = \frac{4 \times 10}{1 \times 8} = \frac{40}{8} = 5$ val. of V^2

Students must bear in mind that these numerical values given to the above are only given so that they may exercise and test the accuracy of each rule with very little trouble until they have thoroughly grasped the idea.

The same may be said of Nos. 7, 8, 9, 10, and 11. Say H.P. = 1, P = 3, Q = 11, and for the sake of brevity take 33000 as horse-power and call it 33, then we have the following:—

(7) $H.P. = \frac{PQ}{33} = \frac{3 \times 11}{33} = 1$ val. given to HP.

(8) $Q = \frac{H.P. \times 33}{3} = \frac{1 \times 33}{3} = 11$ val. given Q

(9) $P = \frac{H.P. \times 33}{11} = \frac{1 \times 33}{11} = 3$ val. given to P

With regard to 10 and 11, take the water-gauge as 2 inches and the pressure will be 10·4 :—

(10) $W.G. = \frac{10{\cdot}4}{5{\cdot}2} = 2$ val. given for W.G.

(11) $P = W.G. \times 5{\cdot}2 = 2 \times 5{\cdot}2 = 10{\cdot}4$ val. for P

Owing to the important part the square and cube roots play in calculations on mining ventilation, it is necessary for mining students to understand what is meant by the square or second power, also the cube or third power of a number. Besides this it is requisite for the persevering student to make himself thoroughly acquainted with the methods of extracting the square and cube roots of numbers. For this purpose I will give an example of each with an explanation of the method used.

SQUARE ROOT.

The square or second power of a number is the product of a number multiplied by itself, *i.e.*, $2 \times 2 = 4$, which is the square of 2 usually expressed in writing by a small figure above the number a little to the right, thus 2^2

The square root of a number, is a number which taken twice as a factor will produce a given number and is called the square root of that number. Take 9, the number 3 is taken twice in 9, consequently in this 3 is termed a factor of that number, which is the square root also of that number.

When the square root of a number is required, it is generally represented in writing by the sign $\surd$ placed before the number, thus, $\surd 9$ means the square root of 9, which is 3.

If the extraction of the square root of a number is required, you must first separate the given number into periods containing two figures each. In whole numbers place the first point over the unit figure (that is moving from right to left), thus $\dot{1}23\dot{4}5$. If on the other hand we have decimals, then every second figure to the right must be pointed thus $\surd{\cdot}6\dot{7}5\dot{4}$. The same rule applies to decimals even when such figures as the following are used $\surd{\cdot}0\dot{6}5\dot{4}$ or $\surd{\cdot}0\dot{0}6\dot{4}$, and as such figures as these perplex younger students, I will work out an example of each as a guide for future studies.

Example I.—Find the square root of 627264. First of all separate the number given into periods of two figures each, commencing at the units figure and moving to the left thus $6\dot{2}7\dot{2}6\dot{4}$.

We must now find the number whose square is the greatest contained in 62, this is found to be 7 whose square is 49,

```
   7 ) 627264 ( 792
       49
      ----
 149 ) 1372
       1341
      ----
1582 ) 3164
       3164
```

place this number underneath 62 and subtract this leaves 13. The 7 is put on the right hand side of the dividend as the first figure of the root required. To the right of 13 bring down the numbers of the next period which is 72, which makes the dividend 1372.

We must now double 7, the part of the root already found, thus $7 + 7 = 14$. This is placed on the left side of the dividend and forms a partial division. Leave out the right hand figure 2 and see how many times 14 is contained in 137, this is found to be 9.

Annex this number to the partial division, making it 149; also to the part of the root already obtained making it 79. Multiply 149 by 9 and the product 1341 is placed in the dividend underneath 1374, from which it is subtracted and leaves a remainder of 31. Bring down the next period of two figures 64 and place them on the right hand side of 31 making it 3164. Double 79 the part of the root already obtained from a partial division $79 + 79 = 158$, place this number on the left hand side of the dividend 3164. Leave out the 4 and see how many times 158 is contained in 316, this we shall find to be 2. Annex this number as before both to the partial division 158 (making it 1582), and to the part of the root (79) already obtained making it 792. Multiply 1582 by 2 and the product 3164 place in the quotient, and as the two numbers are equal there is no remainder left.

We now see that the square root of 617264 is 792. Expressed in writing it would be

$$\sqrt{627264} = 792. \quad \text{Proof } 792^2 = 627264.$$

Example II. — Find the square root of ·0484. Divide this as previously explained and find the number whose square is the greatest contained in 4 and work out as before.

```
 2 ) ·0484 ( ·22
       4
    ----
42 )  84
      84
      ==
```

Thus $\sqrt{\cdot 0484} = \cdot 22$. Proof $\cdot 22 = \cdot 0484$.

Example III.—Find the square root ·001089, this is divided into periods as before As there are two cyphers first we shall have to place ·0 as a partial root, and find whose square is the greatest contained in 10 the next period, and proceed as before.

```
 3 ) ·001089 ( ·033
         9
       ---
63 )   189
       189
       ===
```

Thus $\sqrt{\cdot 001089} = \cdot 033$. Proof $\cdot 033^2 = \cdot 001089$

(*To be continued.*)

At the First-Class Certificate Examination, held at Cardiff, in April last, the following students of the Mining Correspondence Class, Nuneaton, conducted by Mr. George M. Bailes, Mining Engineer, gained certificates as manager of a mine:—Messrs. William Slocombe, of Newbridge, Mon.; and John Nicholls, of Crumpmeadow, Cinderford. No failures.

EXAMINATION QUESTIONS ANSWERED.

BY A FIRST-CLASS CERTIFICATED MANAGER.

Questions given at the Manchester Examination for First-Class Certificates of Competency, Dec., 1894.

(COMMENCED IN NO. 12, VOL. III.)

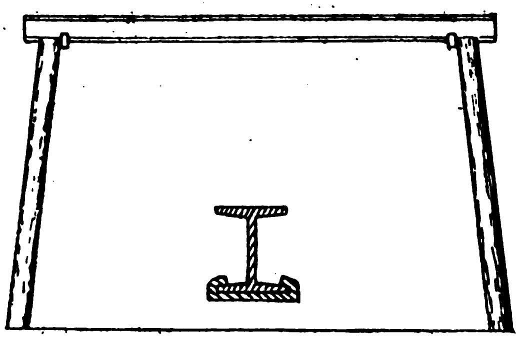
IV.—Practical Working.

Q. 17.—Some underground workings are liable to take fire by spontaneous ignition. What is the reason of this, and what are the principal precautions to be taken in order to avoid danger to life in such mines? (6 marks.)

A.—The principal cause of spontaneous combustion underground is the oxidation of the coal, but this may be assisted by the decomposition of iron pyrites or the grinding action caused by the great pressure of the roof. Damp small coal favours the absorption of ogygen, and as heating results from the oxidation of the coal, if it continues for any considerable period, it may be sufficient to ignite the small timber, which may be in the goaf, or even the coal. A mine subject to spontaneous combustion should be worked in districts, so that any one could be isolated if necessary from the other workings. If working longwall the goaf should be tightly packed and all timber and small coal kept out. A good ventilating current should be circulated in the workings in order to keep down the heat, and if a fire occurs an attempt should be made to dig it out or quench it with water; if these should fail the only resource is to dam the working off. To avoid danger to life I would remove the workmen from the district in which the presence of fire was detected in a fiery mine until an attempt had been made to effectually deal with it, and I should see that the men engaged on exploring, and attempting to quench the fire, did not stay too long in the poisonous gases.

Q. 18.—Give the cases where in your opinion steel girders are more suitable than timber for securing roofs. Show by a sketch how you would fix them? (6 marks.)

A.—Steel is more suitable than timber in permanent roads, the roof of which is subjected to a light steady pressure, but they are worthless in a mine subject to creep. In many roads which are required to be kept open for a considerable period the atmos-



phere so decays the timber that it may have to be re-timbered several times. Girders would, no doubt, be preferable under the circumstances. For an important position the girders would be supported on side walls of brickwork, or upon chocks, but for haulage roads the usual practice is to employ ordinary timber props. As the flanges of the guides are flat and smooth, it is necessary to make provisions to prevent the girder from slipping off the props if there is any side pressure. The best method of securing the girders is that shown by the sketch. Small pieces of bar-iron are placed on the bottom flange, about 6 inch from each end, and are turned up so as to grip it firmly as shown. A slight notch is made in the top of the prop to prevent the girder slipping off sideways.

Q. 19.—If you have an underground engine to fix, state as clearly and as fully as you can what precautions you would take against fire or smoke and consequent risk to property or life, first in the erection and afterwards in the working of the engine. (6 marks.)

A.—I would have the sides of the engine house and along the roads, for a distance of ten yards on each side from the engine-house, protected by brick walls. If the roof required supporting I would use girders or arching, and would exclude timber altogether in the erection. The engine bed plate should be laid on stone foundations and the floor of the engine-house should be paved. A line of water-pipes should be laid to the engine-house, and there should be also kept there a water tank, a bucket, and a hose pipe, ten feet long. In the working of the engine I would see that all superfluous oil and refuse was removed frequently, that only a small quantity of oil was allowed to the engineman at one time, that he was provided with a box of two compartments for cotton waste, that the storekeeper was authorised to give not more than a definite quantity of cotton waste at one time, that the engineman delivered up the correct quantity of dirty waste before the clean waste was given to him, that the engineman was sheltered from the ventilating current (if this was necessary) by corrugated iron sheets and not brattice cloth, that he kept cool all parts of the engine which are likely to become heated by friction, that every precaution is taken to prevent sparking, and that none but safety lamps be used.

V.—Mine Gases, Lighting, and Ventilation.

Q. 20.—What gases are given off in a coal mine from spontaneous combustion or gob fires, from the coal itself, from lamps, and from shot firing ? What are their properties and chemical compositions ? (4 marks.)

A.—The principal gases given off from spontaneous combustion are carbon monoxide and carboni cacid, from the coal, light carburetted hydrogen and carbonic acid, and from lamps, carbonic acid. The gases given off from shot firing will depend upon the explosive employed, but the principal gases are carbonic acid, carbon monoxide, and sulphuretted hydrogen.

LIGHT CARBURETTED HYDROGEN, commonly known as firedamp, may be said to be the most dangerous gas found in mines by reason of its explosive properties. Its symbol is CH_4, specific gravity 0·559, and consists of one atom of carbon to four of hydrogen. As it is much lighter than the atmospheric air it is to be found in the higher portions of mine. This gas becomes explosive when 7 or 8 % is present in the atmosphere, and reaches its greatest explosive point when 10 to 12 % is present; when 20 % or more is present the mixture will not explode.

CARBONIC ACID. Its symbol is CO_2, specific gravity 1·53, is composed of one atom of carbon to two of oxygen, and will not support combustion or life.

CARBON MONOXIDE. Its chemical symbol is CO, being one atom of carbon combined with one of oxygen. Its specific gravity is 0·97, and ½ % will, if breathed for any length of time, prove fatal to life. Its presence is not detected by the flame of a safety lamp until present in large quantities, though when this gas is present the flame burns a little brighter.

SULPHURETTED HYDROGEN. This gas is only given off in small quantities, and when

present may be detected by its offensive smell, which is somewhat like that of rotten eggs. Its does not support combustion, is injurious to life, and burns with a blue flame. Its symbol is SH_2, specific gravity 1·17, and consists of one part of sulphur to two of hydrogen.

Q. 21.—A certain quantity of air is passing through an airway, what increase of water-gauge, and what increase of power would be required in order to pass 25% more air through the same airway? (4 marks.)

A.—To increase the quantity of air by 25% we must increase the velocity in the proportion of 5 to 4, or as 125 is to 100.

The pressure varies as the velocities squared, therefore, if a velocity of 4 gives a w.g. of, say x, a velocity of 5 will give—

$$\frac{5^2}{4^2}\, x \text{ or } = \frac{25}{16}\, x = 1\tfrac{9}{16}\, x$$

or there will be an increase in the w.g. of nine-sixteenths of its original height.

The quantity varies as the cube root of the power applied, or to state this in other words, the power varies as the quantities cubed, $4^3 = 64$, $5^3 = 125$, therefore if y = original power $\frac{125}{64} y = 1\frac{61}{64} y$ or an increase in the original power of $\frac{61}{64}$

Q. 22.—What rules should be followed in dividing or splitting the air-currents in a mine? What practical limits to the number of splits are imposed by considerations of economy and efficiency? (4 marks.)

A.—The splits should commence as near the downcast shaft and join again as near the upcast shaft as possible. They should be of equal lengths to obviate regulating, and each should have its separate intake and return. The condition of a mine does not always allow the above being strictly carried out, but they should be kept in view and the best compromise made. The practical limits to the number of splits, imposed by considerations of economy and efficiency, is reached when the sum of the resistances of the airways underground is equal to that of the shafts.

Q. 23.—What are the four principal factors in ventilation which influence the circulation and upon which the quantity of air circulating depends? (4 marks.)

A.—The following are the principal factors:
S = Rubbing surface of the airway in sq. ft.
V = The velocity of the air-current.
A = The area of section of an airway.
P = The pressure per square foot producing ventilation.

Q. 24.—Two shafts are each 900 feet deep, the barometer stands at 29·5 inch, the temperature of the downcast is 50° F. and that of the upcast 150° F., what is the ventilating pressure? (4 marks.)

A.—Find the weight of a cubic foot of air in each shaft, then multiply this by the depth of the shaft in each case. Subtract one from the other, and the result is the ventilating pressure:—

$$W = \frac{1{\cdot}3253 \times 29{\cdot}5}{459 + 50} = {\cdot}07681 \text{ downcast.}$$

$$W = \frac{1{\cdot}3253 \times 29{\cdot}5}{459 + 150} = {\cdot}06419 \text{ upcast.}$$

$$P = {\cdot}07681 \times 900 = 69{\cdot}129 \text{ lbs., downcast.}$$

$$P = {\cdot}06419 \times 900 = 57{\cdot}771 \text{ lbs., upcast.}$$

$$11{\cdot}358 \text{ lbs. pressure.}$$

or it may be put thus—

$$P = 900 \times \frac{1{\cdot}3253 \times 29{\cdot}5}{459+50} - 900 \times \frac{1{\cdot}3253 \times 29{\cdot}5}{459+150}$$
$$= 11{\cdot}358 \text{ pressure as before.}$$

Q. 25.—Show how to ventilate the workings on the annexed plan. (4 marks.)

(Two correct methods of ventilating the plan given at this examination appeared in No. 11, Vol. III.)

Oral examination, 15 marks. Total number of marks, 132.

Two-thirds of the total number of marks to pass.

The time allowed for the first nine questions was two hours, and for the remainder, five hours, giving a total of seven hours.

The Questions set for second-class certificates of competency with answers to same will commence in next issue.

SCIENCE & ART DEPARTMENT EXAMINATION.

PRINCIPLES OF MINING.

1895.

GENERAL INSTRUCTIONS.

If the rules are not attended to, the paper will be cancelled.

You make take the Elementary, or the Advanced, or the Honours paper, but you must confine yourself to one of them.

Put the number of the question before your answer.

You are to confine your answers *strictly* to the questions proposed.

Your name is not given to the Examiner, and you are forbidden to write to him about your answers.

The examination in this subject lasts 3 hours.

First Stage or Elementary Examination.

INSTRUCTIONS.

You are permitted to attempt only *seven* questions. Four of these may be selected from Section A, and the remainder from Section B or from Section C, but *not* from both.

The value attached to each question is the same.

SECTION A.—GENERAL.

1. Describe with figures and dimensions two forms of miners' picks as used either in coal or metalliferous mining.

2. What is the composition of common blasting powder, and what methods have been suggested for increasing its efficiency ?

3. Give a sketch of the construction of a horse-whim or gin, stating within what limits it can be usefully applied.

4. Describe two methods of timbering a level suitable to resist side and top pressure respectively.

5. Give the weight per fathom, ultimate strength, and safe working load of a crucible steel wire rope 4 inches in circumference.

SECTION B.—COAL.

6. Describe the general character and structure of a coal seam, and its associated strata.

7. Describe a simple method of boring for coal, and state how the section is recorded when solid cores are not obtained.

8. How can a level be driven in fiery measures without the use of explosives ?

9. Describe the pillar and stall method of coal working, in two modifications.

10. How is a coal mixed with shale prepared for market ?

SECTION C.—METALLIFEROUS.

11. What are stratified and unstratified mineral deposits ? Describe the characters of each kind, giving some examples.

12. What are ores, veinstuff, waste and deads ? Give some examples of the application of these terms.

13. What are the principal methods of working on lodes, and what conditions are best suited to each one ?

14. How are the pumps of a deep mine usually arranged, when worked by an engine at the surface ?

15. What minerals are commonly found in the veinstuff of a tin lode, and how is the tin ore separated ?

Second Stage or Advanced Examination.

INSTRUCTIONS.

Read the General Instructions.

You are permitted to attempt only *seven* questions. Four of these may be selected from Section A, and the remainder from Section B or from Section C, but *not* from both.

The value attached to each question is the same.

SECTION A.—GENERAL.

21. Illustrate the construction of—

a. A cage for a vertical shaft, or
b. A skip for an inclined shaft,

giving details of the method of attachment of the winding rope.

22. Describe the construction of a dam to resist a heavy pressure of water in a level.

23. Describe some method of raising water from a deep mine without pumps.

24. What gases are likely to be found in the air of coal and metal mines respectively ? State generally the appliances required for ventilating either class of mines.

25. What arrangements are desirable in connection with the winding arrangements of a deep mine to ensure safety when winding at a high speed ?

SECTION B.—COAL.

26. What are faults in coal seams, and how may they be expected to influence the working of mines ?

27. Describe the operation of boring for coal at a great depth by a method giving solid cores of the strata passed through.

28. Describe in detail a method of long-wall working suitable for a 4-feet coal with a dip of 1 in 6, showing the best method of securing the face.

29. Describe the Pieler and Clowes methods of testing for gas.

30. Notice some of the principal forms of screens used for sizing coal.

SECTION C.—METALLIFEROUS.

31. What ores are found in the carboniferous limestone formation of England ? Give some examples of particular mines.

32. What are the principal ores of manganese, and under what conditions have they been found in this country ?

33. How can prospecting for lodes be carried out in a country with a heavy drift covering ?

34. Describe a method of working on a large lode where the excavation is too wide to be spanned by single timbers.

35. Describe the round buddle and some of the newer slime dressing machines developed from it.

Honours Examination.

INSTRUCTIONS.

Read the General Instructions.

You are permitted to attempt only *six* questions.

The value attached to each question is the same.

41. Give an account of the South Staffordshire coalfield, noticing such points in geological structure and methods of working as are of special mining interest.

42. What are the principal copper-producing districts of the world ? Describe one of them in detail.

43. Describe in detail the construction and method of erection of a system of tubbing for a pit 16 feet in diameter, starting from a depth of 70 yards below the surface.

44. Describe the Brandt rotary rock-drill, and give examples of results obtained with it.

45. What appliances are required for maintaining and measuring the air circulation in a mine, and what power will be required to move 100,000 cubic feet per minute at 3½ inches water-gauge ?

46. Give a general description of the Cornish pumping engine, and notice some of the newer forms of engines that have been introduced as substitutes.

47. A system of mechanical haulage is required in a level 1,800 yards long to deliver 200 tons of coal in 10 hours to a pit eye 400 yards below the surface. State generally what arrangements you would prefer for this work.

48. What errors in direction are likely to arise in surveys made with the magnetic needle, and how can such errors be controlled and corrected ?

49. What plant will be required for washing 100 tons of small coal per hour by the Lührig or some other approved method ?

50. Give an account of the methods of working and milling the ore of the banket formation of the Transvaal.

AWARDS.

FOR ANSWERS TO COMPETITION QUESTIONS—No. 14.

ELEMENTARY—J. Wheatcroft, 8, Longsight Terrace, Kinsley Hemsworth, near Wakefield.

Commended—F. Cherry, W. G. Jones, D. Morgan, T. Webster, J. Finch.

ADVANCED—Thomas Rimmer, 38, Clarence Street, Newton-le-Willows.

Commended—J. Crone, H. Hall, C. A. Sandiford, W. Vickers, J. Moore, W. P. Laws, T. Newton, J. Jones, J. Stephenson.

FIRST-CLASS—M. Brown, Butterknowle, Darlington.

Commended—S. Thorpe, S. Davies, T. W. Brown, J. Wallwork, W. Slocombe, G. Daykin, J. Davis.

ANSWERS TO QUESTIONS.

No. 14 Set—In No. 11, Vol. III.

ELEMENTARY.

ADVANTAGES AND DISADVANTAGES OF CHAINS, HEMP ROPE, IRON AND STEEL WIRE ROPE.

Question 1.—Compare briefly the relative advantages and disadvantages under different conditions of chains, hemp rope, and iron and steel wire rope.

Answer.—Chains may be used with advantage for shallow pits, because of the facility with which they may be coiled round small barrels or drums; but they are very rarely used for winding purposes owing to the disadvantage of their excessive weight. For the same reason they are seldom used for hauling purposes underground, but they are successfully applied to endless haulage on the surface. Hemp ropes may be used with advantage in sinking and pumping shafts for supporting or lifting heavy weights, such as pumps. They are very rarely used for winding purposes, except in shallow pits, on account of the huge size of rope that would be necessary to withstand the strain of the loads of minerals now usually wound; and again its weight compared with steel wire rope working under the same conditions would be three times as heavy and would not wear for so long a time. Steel wire rope has the advantages over iron wire rope of only weighing two-thirds its weight and at the same time not being so large for the same working load. Steel wire ropes are higher at first cost in about the proportion of 6 to 4·5; but the usual life of a steel wire rope as compared with an iron wire rope under similar conditions is about as 9 to 5. When taken out of the shaft they can be used for hauling purposes, whereas the large iron wire ropes are useless for that purpose.

JOSEPH WHEATCROFT.

TIMBERING.

Question 2.—Describe with sketch the ordinary timbering of a level.

Answer.—The simplest way of supporting the roof of a level is to cut or notch into the coal or stone on each side, when it is sufficiently strong, for the reception of a bar or crown-tree (fig. 1), or to notch on one side

Fig. 1.

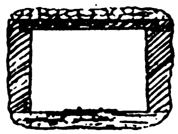


Fig. 2.

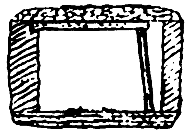
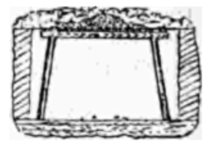


Fig. 3.



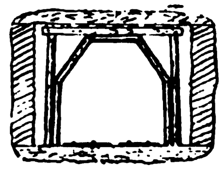


Fig. 4.

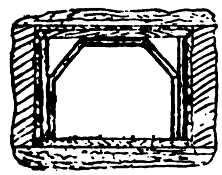


Fig. 5.

only and place an upright prop under the bar at the other end (fig. 2). When the sides are not strong enough, or the span of the roadway is too wide, a prop is fixed under each end of the crown-tree, slightly inclined from the perpendicular (fig. 3). If the roof is very loose and crumbly, long pieces of timber are placed on the top of the bars or crown-trees, stretching from one to the other (at right angles to the bar) right across the level; in this manner a safe covering is made overhead, as it prevents the loose stone from dropping out between the bars. In high and wide places stronger timber than usual is used; also on all main roads, where there is horse or engine haulage; at sidings or pass-byes; and at all places where the nature of the roof requires it. In places where two sets of rails, or a travelling road for men by the side of the rails is required, a more substantial system of timbering may be adopted (fig. 4). A convenient method of timbering when the roof, sides, and floor require supporting is shown by fig. 5.

JOSEPH WHEATCROFT.

ADVANCED.

THE CAPELL FAN.

Question 3.—Describe what you consider to be one of the best of modern fans. Give sketch.

Answer.—There are different types of fans in use at the present time which are giving good results in various parts of the country. Walkers' patent indestructible fan, which was introduced a few years ago, has proved itself successful. A large number of these fans have recently been fitted up in this country and are giving good results. I shall describe the Capell fan, which I consider to be the best.

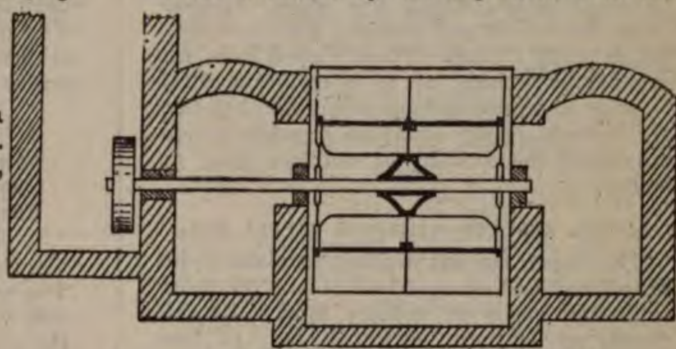
In the year 1886, an enclosed Capell fan was applied to colliery ventilation at Sheffield. It was a double inlet fan, 10 feet diameter, each inlet being 5 feet 6 inches diameter. Elaborate experiments were made under the supervision of Mr. W. Fairley and Mr. Jonah Davis, of Wolverhampton. This Capell fan, at 210 revolutions per minute, gave 100,085 cubic feet of air, with 3·1 inch water-gauge and a useful effect of 82 per cent. Since that year a large number of Capell fans have been applied at English collieries, producing volumes of air up to 400,000 cubic feet of air per minute, and water-gauges up to $7\frac{1}{2}$ inches. In Germany, the first Capell fan was reported upon in the early part of 1889, and at present there are not less than 73 Capell fans at work in the Continental coalfields, some producing a water-gauge up to 10·7 inches.

THE CAPELL FAN AND ITS CONSTRUCTION.

The Capell fan is usually built on a drum or cylinder, closed on one side. In this cylinder are formed six openings,

Cross section, showing evasé chimney.

equally spaced round the cylinder. The combined area of the six openings is always greater than the area of the inlet, so that the air is not throttled in its passage, as would at first sight seem to be. From the edge of each opening, on the contrary side to the direction of rotation, a wing, whose area is slightly larger than the opening, dips towards the centre, at a distance which has been determined by experiments. This fan is known as the Radial Ventilator; used as an open running fan it passes very large volumes of air at moderate water-gauges. On this cylinder is built the second fan of the now well-known Capell Mine Ventilator. The outer wings are placed between side discs, generally from $\frac{3}{8}$ of an inch to $\frac{1}{2}$ an inch thick, on the driving side of the fan, and secured with angle irons to the side discs and rivetted to the cylinder. These wings spring from the opposite edge of the opening in the cylinder to that at which the minor wings are secured, and thus cover the openings or port-holes. The outer wings are wider than the port-holes, which thus discharge their air into a medium, put under high water-gauge by the rotation of the outer wings. A two-fold object is thus achieved; the spout of the air into the rarified space is increased above the centrifugal velocity produced by the circumference of the inner fan, and the energy of the air is made available by the expansion into the



Longitudinal section, showing double inlet.

outer fan chambers, which act in that respect like the evasé chimney of the Guibal fan. Fig. 1 is a cross-section of the Capell fan, and gives a sufficiently clear idea of the blades of the inner fan, the blades and discs of the outer fan, and the spiral casing leading into the evasé chimney. To further increase the useful effect of the Capell fan an expanding spiral casing was added, with a double evasé chimney, that is to say, unlike the Guibal fan chimney, which is only evasé in one sense, the Capell fan chimney is made hopper shape, widening out both ways and enabling a much larger area of discharge to be obtained with a short chimney. The Capell fan chimneys are seldom higher than a diameter of the fan above the centre line of the fan.

RECENT IMPROVEMENTS IN THE CAPELL FAN.

A double inlet fan, by which, of course, is meant a fan which receives air on both sides, consists of two complete single inlet fans, built on a dividing disc, $\frac{3}{8}$ of an inch thick. Recently an improvement has been made in

the double inlet fans: the inner wings are inclined at an angle to the axis and thus grip the air more firmly and pass it over to the side opposite to the inlet. Mr. Capell states that it was well known that in single inlet fans of the Guibal type more air was always passed on the inlet side than at the opposite side, to the extent of not less than 40 per cent. In the improved Capell fan, while the inner wings are inclined the outer wings are kept parallel, with the result that the air is more evenly distributed, and the gauge and the volume are improved. A Capell fan, 12 feet 6 inches diameter, has recently been constructed on this principle to produce 125,000 cubic feet of air per minute, with a water-gauge of 14 inches, from the performance of a previous fan of the same diameter, by single inlet, which has given 140,000 cubic feet of air per minute, with a water-gauge of 8½ inches. These Capell fans are capable of running up to a circumferential velocity of 15,000 feet per minute = 250 feet per second, being equal to a water-gauge calculated theoretically at not less than 14 inches.

ACTUAL RESULTS WITH THE CAPELL FAN.

The Capell fan has justified its claim to be considered and accepted as one of the most successful types of colliery fans. In the county of Durham, a Capell fan, 12 feet diameter and double inlet, running at 200 revolutions per minute, the engine making 50 revolutions per minute, gave 156,000 cubic feet of air, 3·3 inches water-gauge, and 70 per cent. useful effect. In the county of Derbyshire, a single inlet Capell fan, 12 feet 6 inches diameter, running at 216 revolutions per minute, gave 123,000 cubic feet of air, 68·6 per cent. useful effect. In the county of Yorkshire, a double inlet Capell fan, 10 feet diameter, running at 210 revolutions per minute, gave 188,000 cubic feet of air, 3·1 inches water-gauge, and 82 per cent. useful effect. Mr. Capell states that quite recently a Capell fan, 15 feet diameter, gave, as he believed, the highest useful effect yet obtained. At an English colliery the Capell fan gave its guarantee of 150,000 cubic feet of air, with 6 inch water-gauge, at 220 revolutions per minute. There are double inlet Capell fans, with similar water-gauges, and producing 300,000 cubic feet of air per minute, at Wrexham, Barnsley, and Chesterfield. At Barnsley there is a double inlet Capell fan, 17 feet 6 inches diameter, to produce 400,000 cubic feet of air per minute, with 5 inch water-gauge. On the Continent of Europe the Capell fan is held in much esteem.

THOMAS RIMMER.

FIRST-CLASS.

THE PRINCIPAL GASES IN A MINE BEFORE AND AFTER AN EXPLOSION OF FIREDAMP AND COAL DUST.

Question 4.—What are the principal gases in a mine before an explosion of firedamp and of coal dust. Give an account of the resultant gases and how they are formed.

Answer.—The principal gases in a mine before an explosion of firedamp and coal dust are given in the annexed table, which has been taken from "*Dron's* Mining Formulæ." The dust present in the atmosphere will be at first in a solid state, hence it will be left out at present:—

Mixture.	Before Explosion. By Volume. cu. ft.	per cent.	By Weight. lbs.	per cent.
Nitrogen ...	740	71·15	58·03	72·21
Oxygen......	200	19·23	17·85	22·21
Firedamp...	100	9·62	4·48	5·58
Totals.	1040	100·00	80·36	100·00

The resultant gases formed by the explosion will vary as the gases which have caused the explosion vary. Therefore, the resultant atmosphere is influenced by the constitution of the explosive atmosphere. The following tables show the result from different atmospheres. There is also appended a table showing the gases which may be expected to be given off or distilled from the coal dust, as the heat of the explosion will produce distillation similar to distilling gas from coal, only in this case it is instantaneous; but these gases will not be found in their pure distilled state, for they will propagate and magnify the explosion, and their resultant gases will be those of a deadly nature. After an explosion of one volume of firedamp, mixed with 9·52 volumes of air, the resultant gases will be carbon dioxide, water vapour, and nitrogen, the whole constituting that deadly atmosphere known as afterdamp. The moment after the explosion the result will be:

			per cent.
Nitrogen	=	N	= 71·48
Watery Vapour	=	H_2O	= 19·01
Carbon Dioxide	=	CO_2	= 9·51
			100·00

But the watery vapour or steam will immediately condense, leaving an atmosphere slightly changed, as:—

Nitrogen	88·26
Carbon Dioxide	11·74
	100·00

Another example:—

Mixture.		After Explosion. By Volume.		By Weight.
	cu. ft	per cent.	lbs.	per cent.
Nitrogen.........	740	71·15	58·03	72·21
Carbon Dioxide	100	9·62	12·29	15·29
Watery Vapour	200	19·23	10·04	12·50
Totals.	1040	100·00	80·36	100·00

ANALYSIS OF THE PRODUCTS OF THE DISTILLATION OF BITUMINOUS COAL.

	per cent.
Hydrogen	50·05
Marsh Gas	32·87
Carbon Monoxide	12·89
Olefines................................	3·87
Nitrogen	—
Carbon Dioxide	·32
	100·00

The resultant gases of an explosion are formed as follows:—The oxygen of the air is combined with the carbon and hydrogen of the firedamp; with the carbon it forms carbon dioxide CO_2 and with the hydrogen it produces water vapour H_2O; the nitrogen is left unchanged in its elementary condition, but it is unmixed with oxygen, hence the atmosphere is very deadly. MYLES BROWN.

AIR-CROSSINGS.

Question 5.—Which do you consider the better, an air-crossing sufficiently strong to resist an explosion, or one that would be destroyed? Give reasons for your answer.

Answer.—I prefer having the air-crossings put in as strong as possible, their strength being such as to resist the force of an explosion. This would, no doubt, have its disadvantages in case an explosion occurred, because the explosive blast would be confined, which would cause it to be more devastating as it travelled through the mine; yet one great benefit to be derived would be, the ventilation could soon be reinstated so as to purify the air of the mine. This is, no doubt, the most important item in connection with the arduous work of rescuing the entombed miners and repairing a mine after an explosion. Both methods have their disadvantages, but of two evils we must try and choose the lesser. Their advantages and disadvantages are as follows:—Method preferred, that of putting in stoppings so as to resist the force of an explosion. Advantages: (1) Greater safety, (2) saving of cost, as the ventilation, etc., can be reinstated immediately after the explosion, (3) no gas from the old goaves would feed the explosion. Disadvantages: (1) Larger first cost, (2) explosive blast stronger, owing to being confined. Supposing the stoppings to be put in so as to be destroyed by the explosive blast:—Advantages: (1) The explosive blast would be more spread or extended, thus it would be weaker, (2) less first cost. Disadvantages: (1) Ventilation totally deranged, (2) gas would issue from behind the stoppings, (3) it would be impossible to reach the entombed workmen until the ventilation could be restarted, which would take considerable time, (4) the miners could not escape, owing to the fouled atmosphere. MYLES BROWN.

EDITORIAL NOTES

THE MODE OF GRANTING CERTIFICATES TO MANAGERS OF MINES.

We are pleased to see that the Colliery Managers' Association have taken this subject up. Our readers will remember we expressed our opinion very distinctly in a criticism on the colliery managers' examinations a few issues ago, and shortly afterwards, at a meeting of the Colliery Managers' Association, the following remarks were made:—

"CHAIRMAN (T. W. T. Brain, Esq., Assoc. M.I.C.E.): Gentlemen, the next item on the agenda is 'To further consider the method of granting certificates to managers of mines.' This is a very important item, and it is one upon which I feel very strongly and have felt strongly for years. I have, time after time, brought forward my views on the matter. I think the present mode of examination and granting certificates is unsatisfactory and requires radical alteration; but I fear that with the long agenda we have to day, it would be impossible to give proper consideration to the matter. Therefore, I suggest that we postpone the consideration of this item until the next Council meeting. (AGREED *nem con.*)

Mr. DONALD MUNROE: Can anything be done in the meantime towards drafting a scheme? If we are to condemn the present mode I think something of that kind should be done."

Mr. P. MEHERS: I move that this matter be referred to the Parliamentary Committee, for them to take it into consideration and deal with. (CARRIED.)

Mr. M. WALTON BROWN: If this matter is referred to them I may say for their information that there is a very interesting article on the subject in *Mining*, which is published by Messrs. Strowger & Son, Wigan.

Mr. H. PALMER: May I ask whether, in case the Council at the next meeting come to any conclusion with regard to this subject, they would be prepared to embody their conclusions in the representations that they make when they attend before the Home Secretary with a view of getting some modification inserted in the next Bill."

The Science and Art Examinations.

Our readers will remember that in No. 12, Vol. III., we gave a few questions which we advised students who purposed sitting for the Elementary Stage of the Science and Art Department Mining Examination to look up, and although we gave comparatively few questions we were fortunate enough to name so many as *six* which were asked at the Examination. The Science and Art Department Examination Questions may be found on page 170 of this issue, and it will be seen by referring back to No. 12, Vol. III, that we named questions 1, 3, 4, 6, 7, and 9; as the number of questions to be answered was only seven it is needless to say that those students who did as we suggested will come up successfully.

CORRESPONDENCE.

Size of Engine Required.

Sir,—The following is an answer to J.P.

Question.—It is required to draw 400 tons of mineral from a depth of 600 yards in ten hours. Cages holding four tubs each, tubs weighing about 6 cwt. each, and carrying about 12 cwt. of mineral. Required the size of drum, size of cylinders, and length of stroke of engines, steam pressure 75 lbs.

$400 \times 20 = 8000$ cwts. mineral raised in cwts, taking the cages to be half the weight of mineral, also the tubs. The total weight will be $8000 + 4000 + 4000 = 16000$ cwts., then the number of runs made in ten hours will be $\frac{8000}{48} = 166{\cdot}6$, and the time of each run is $\frac{10 \times 60}{166{\cdot}6} = 3{\cdot}6$ minutes.

$$\frac{16000 \times 112 \times 600 \times 3}{33000 \times 10 \times 60} = 162{\cdot}91 \text{ H.P. of engine.}$$

Mineral. Cage. Tubs.
48 + 24 + 24 = 96 cwts. working load.

$\frac{96}{10} = 9{\cdot}6$ lbs. weight of rope per fathom required.

$\frac{9{\cdot}6}{{\cdot}014} = 685{\cdot}78$ circumference of rope in $\frac{1}{8}$th of inches, squared $\sqrt{685{\cdot}78} = 26{\cdot}17$ circumference of rope in $\frac{1}{8}$th of inches, $\frac{26{\cdot}17}{8} = 3{\cdot}27$ inches circumference of rope.

$600 \times 3 = 1800$ feet depth of shaft.

Take the revolutions at 15 per minute, the number of revolutions made in one run will be $15 \times 3{\cdot}6 = 54$ revolutions, then the circumference of drum will be $\frac{1800}{54} = 33{\cdot}148$ feet.

$$\frac{33{\cdot}148}{2{\cdot}1416} = 10{\cdot}55 \text{ feet diameter of drum.}$$

H.P. multiplied by 126050, and divided by the number of revolutions per minute multiplied by the steam pressure, and by the number of cylinder, and extract the cube root will give the diameter of cylinders, and the diameter of cylinder multiplied by by 2 equals the length of the stroke. Thus

$$\sqrt[3]{\frac{162{\cdot}91 \times 126050}{15 \times 75 \times 2}} = 20{\cdot}9 \text{ inches dia. of each cylinder.}$$

$20{\cdot}9 \times 2 = 41{\cdot}8$ inches length of stroke, or nearly 3 feet 6 inch stroke.

Jno. Gray.

(We think this question would bear a different solution. Some other of our readers might oblige.—Editor.)

Automatic Stop Block for Inclines.

Sir,—Will you or any of your kind readers give a sketch of one of the best kind of stop blocks with some automatic arrangement to hold a set of full tubs at the top of an incline, 1 in 3, until they are ready for removal by a rope. An answer in your valuable journal will very much oblige.—X. Y. Z.

COMPETITION QUESTIONS.

No. 17 SET.

To the sender of the best set of Original Answers in each Stage will be awarded the following:—

Elementary 2s. 6d., Advanced 3s. 6d., First-Class 4s. 6d.

A Competitor may only answer one Stage. The best answer to each question will be published with the sender's name and address.

1.—All envelopes must be marked "Competition."
2.—To be written on separate sheets of paper with name attached, and on one side of the paper only. Sketches to be in ink (Indian ink preferred) on *unruled* paper.
3.—Correct name and postal address must be sent.
4.—They must reach us by April 14th, 1895.
5.—The Editor's decision as to winners to be final.

ELEMENTARY.

Question 1.—Describe the principle of the safety lamp, and describe two of the best forms. What method of locking or securing the lamp do you prefer?

Question 2.—What is the composition of common blasting powder, and what methods have been suggested for increasing its efficiency?

ADVANCED.

Question 3.—Accidents frequently occur through using imperfect hooks for supporting the kibble during sinking. Describe and sketch a good form of hook which will not shake loose, either during the wind or in case of an overwind.

Question 4.—State what arrangements are desirable in connection with the winding arrangements of a deep mine to ensure safety when winding at a high speed.

FIRST-CLASS.

Question 5.—What do you consider to be the most effective method of dealing with the question of shot-firing in mines, having in view the prevention of accidents, and economical and practical working? Give a list of the rules which you would have drawn up for the guidance of the shot-lighters.

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MINING

A JOURNAL DEVOTED TO THE INTERESTS OF MINING STUDENTS.

No 15. Vol. III. SATURDAY, JUNE 15, 1895. FORTNIGHTLY. ONE PENNY.

CONTENTS.

EASY LESSONS ON MINE VENTILATION.

By J. CARTER, First-Class Certificated Manager.
(Commenced in No. 9, Vol. III.)

CUBE ROOT.

THE cube or third power of a number is the product of a number taken three times as a factor, thus 27 is the cube of 3, because $3 \times 3 \times 3 = 27$.

The cube of a number is usually expressed in writing by placing a small figure above the number to the right, thus 4^3 means the cube of 4 which $= 64$.

The cube root of a number is represented in writing by placing the symbol $\surd$ over the number, and placing the number ^{3} to the left of the symbol, thus $\sqrt[3]{64}$ means the cube root of that number which is 4.

RULE. Part I.—Point every third figure of the given number beginning at the unit's place; find the greatest cube in the first period and subtract it therefrom. Put the root in the quotient, and bring down the figures in the next period to the remainder to form a dividend.

Part II.—Multiply the square of the root found by 300 for a divisor, and annex to the root the number of times which that is contained in the dividend.

Part III.—Add 30 times the preceding figure (or figures), multiplied by the last and the square of the last to the divisor, and multiply the sum by the last figure of the root. Subtract this from the dividend and repeat the process as far as necessary. Example—Find the cube root of 80677568161. First of all point this number into periods of three figures each, commencing at the unit figure thus—

$$\dot{8}0\dot{6}77\dot{5}68\dot{1}6\dot{1}\ (4321 \text{ Root.}$$

$$4^3 = 64$$

$4^2 \times 300 = 4800$	16677
$4 \times 3 \times 30 = 360$	
$3 \times 3 = 9$	
5169	15507
$43^2 \times 300 = 544700$	1170568
$43 \times 2 \times 30 = 2580$	
$2 \times 2 = 4$	
557284	1114568
$432^2 \times 300 = 55987200$	56000161
$432 \times 1 \times 30 = 12960$	
$1 \times 1 = 1$	
56000161	56000161

Find the number whose greatest cube is contained in 80. This we shall find is 4 whose cube is 64, subtract this from 80 and to the remainder 16, bring down the next period of figures to the right for a dividend making it 16677. Square the root already found and multiply by 300 for a partial divisor, see how many times this is contained in the dividend, we shall find it to be 3. Annex this to the root already found making it 43. Multiply the first figure of the root 4 by the last found which is 3 and by 30. Then the square of the figure of the root last found, and the result of these added together form the next divisor. This divisor multiplied by 3 the

portion of the root last found. Subtract the product from the dividend, and to the right of the remainder bring down the next period of figures to form the next dividend 1170568. We must again find a divisor providing as before. Square the number 43 and multiply by 300, for a partial divisor to this must be added $43 \times 2 \times 30 + 2 \times 2$, because 2 is the next figure in the root. Annex this number to the portion of the root already found making it 432. Multiply the divisor by the last figure in the root and subtract the product from the dividend, and to the remainder bring down the next period of figures, making the dividend 56000161. Find a divisor as before by multiplying the square of 432 by 300 to which must be added $432 \times 1 \times 30 + 1 \times 1$, this forms the next divisor, and we find that it is contained exactly once in the dividend, therefore the cube root required is 4321.

Example II.—Find cube root of 99252847. Point off the figures with periods as before and proceed in like manner.

$$\begin{array}{rr}
 & 99\dot{2}52\dot{8}4\dot{7}\,(463 \\
4^3 = & \underline{64} \\
4^2 \times 300 = 4800 & 35252 \\
4 \times 6 \times 30 = 720 & \\
6 \times 6 = \underline{30} & \\
\underline{5556} & \underline{33336} \\
46^2 \times 300 = 634800 & 1916847 \\
46 \times 3 \times 30 = 4140 & \\
3 \times 3 = \underline{9} & \\
\underline{\underline{638949}} & \underline{\underline{1916847}}
\end{array}$$

A.—463 root required.

Take an example of decimals such as the following:—

Example III.—Find the cube root of ·001906624.

$$\begin{array}{rr}
 & \cdot 00\dot{1}90\dot{6}62\dot{4}\,(\cdot 124 \\
1^3 = & \underline{1} \\
1^2 \times 300 = 300 & 906 \\
1 \times 2 \times 30 = 60 & \\
2 \times 2 = \underline{4} & \\
\underline{364} & \underline{728} \\
12^2 \times 300 = 43200 & 178624 \\
12 \times 4 \times 30 = 1440 & \\
4 \times 4 = \underline{16} & \\
\underline{\underline{44656}} & \underline{\underline{178624}}
\end{array}$$

Cube root = ·124. Proof $\cdot 124^3$ = ·001906624.

FRICTION OF AIR IN MINES.

The first law with regard to the friction of air in mines is that the pressure required to overcome the friction of the air increases or decreases exactly in the same proportion as the area or extent of the rubbing surface exposed to the air increases or decreases, providing the velocity and sectional area of the airway remain the same. If we double or treble the extent of the rubbing surface we also double or treble the friction, and consequently, we require double or treble the the pressure to overcome it. The rubbing surface depends upon the circumference or perimeter of the airway and its length. The following examples are given to show how the rubbing surface is found in various shaped airways:—

Examples.—What is the rubbing surface in each of the following airways:—

(*a*) Airway, 6 feet square and 600 yards long.
(*b*) „ 9 feet by 4 feet 600 „ „
(*c*) Circular shaft, 6·7 ft. diam. 600 „ deep.

(*a*) Rubbing surface $= 6 + 6 + 6 + 6 = 24 \times 600 \times 3 = 43{,}200$ square feet.
(*b*) Rubbing surface $= 9 + 9 + 4 + 4 = 26 \times 600 \times 3 = 46{,}800$ square feet.
(*c*) Rubbing surface $= 6{\cdot}7 \times 3{\cdot}1416 = 21{\cdot}048 \times 600 \times 3 = 37886{\cdot}4$ square feet.

In the above examples we see that a circular shaft or airway offers less rubbing surface for the same length than either of the other two, in fact the circumference of a circle is less in proportion to its area than the perimeter of any other figure is to its area. As the rubbing surface of an airway, in proportion to its area, plays a very important part as a factor in mine ventilation it would be as well to consider here the resistances offered by airways of various sizes. Take an airway 8 feet square and 1000 feet long, the rubbing surface is $8 \times 4 = 32 \times 1000 = 32{,}000$ square feet; but divide this air into four parts, each 4 feet square, and we exactly double the amount of rubbing surface exposed to the velocity of the air for the same area. Therefore, the rubbing surface in the four smaller ones $= 4+4+4+4 = 16 \times 4 = 64 \times 1000 = 64{,}000$ square feet. From this fact we learn that it is better to have one large airway than a number of small ones, even if together they make up the same sectional area. As the pressures employed to ventilate mines are reckoned at so much per square foot of area, and not by the entire pressure employed, I will here give a few examples as exercises for

students, to enable them to find the rubbing surface per square foot of section of airways:

Let S = Rubbing surface
A = Area of section
WG = Water-gauge

Find the rubbing surface per square foot of section in the airways previously given: (*a*) whose rubbing surface is 43,200 feet, area, 36 square feet; (*b*) rubbing surface is 46,800 square feet, area, 36 square feet; (*c*) rubbing surface is 37886·4 square feet, area, 36 square feet:—

$$\text{Rule } \frac{S}{A}$$

(*a*) $\frac{43200}{36} = 1200$ rubbing surface per sq. ft.

(*b*) $\frac{46800}{36} = 1300$ do. do.

(*c*) $\frac{37886 \cdot 4}{36} = 1052 \cdot 4$ do. do.

If the velocities remained the same in the above airways the resistances would vary as $\frac{S}{A}$

If the water-gauge in *a* read ·75, what would it read in *b* and *c*? Velocity to be the same in each case.

As the rubbing surface per square foot of section *b* is greater than *a*, the water-gauge in *b* must be greater in the same proportion.

$$\therefore \text{WG in } b = \frac{1300}{1200} \times \cdot 75 = \cdot 81.$$

Again, as the rubbing surface per square foot of section *c* is smaller than *a*, the water-gauge in *c* must be lower in the same proportion.

$$\text{WG in } c = \frac{1052 \cdot 4}{1200} \times \cdot 75 = \cdot 877 \times \cdot 75 = \cdot 65775.$$

The friction of air in mine ventilation varies directly as the rubbing surfaces due to different lengths in the same airway, so that according to this rule as we increase or diminish the length of the airways so do we increase or diminish the friction. Therefore, the pressure also increases or decreases accordingly.

Example.—Take an airway whose pressure or resistance is equal to ·5 water-gauge, what would be the water-gauge required to maintain the same velocity if the length of the airway was increased ·75. Suppose the length of the airway in the first instance was 600 feet, and to increase it, ·75 would equal 600 + (600 × ·75) = 600 + 450 = 1050 feet in length.

$$\therefore \text{WG} = \frac{1050}{600} \times \cdot 5 = \cdot 875 \text{ WG required.}$$

Take another example:—An airway, 1000 yards long, required a water-gauge of ·35, what water-gauge would be required to maintain the same velocity if the airway was increased in length to 4000 yards:—

$$\therefore \text{WG} = \frac{4000}{1000} \times \cdot 35 = 3 \times \cdot 35 = 1 \cdot 05$$

The second law of ventilation includes the following:—

(1) Pressures vary as the squares of the velocities. (2) Velocities vary as the square root of the pressures. (3) Pressures are always equal to the resistances, but the velocities vary as the square roots of the resistances inversely, with a fixed water-gauge.

Example I.—The velocity in an airway is 5 feet per second, with a water-gauge of 1·7, what water-gauge would be required for a velocity of 10 feet per second?

Answer.—As pressures vary as the squares of the velocities, therefore, as in this case, the velocity is increased so must there be an increase of water-gauge in the following proportion:—

$$\frac{10^2 \times 1 \cdot 7}{5^2} = \frac{100 \times 1 \cdot 7}{25} = \frac{170}{25} = 6 \cdot 8 \text{ WG.}$$

Example II (*a*).—If a water-gauge of 6·8 gave a velocity of 10 feet per second, what velocity will be given with 1·7 water-gauge?

Answer.—Velocities vary as square roots of pressures:—

$$\therefore V = \sqrt{\frac{1 \cdot 7}{6 \cdot 8}} \times 10 = \frac{1 \cdot 3}{2 \cdot 6} \times 10 = 5 \text{ ft. per sec.}$$

(*b*) If we have a velocity of 5 feet per sec., with a water-gauge of 1·7, what velocity will be given with 6·8 water-gauge?

$$V = \sqrt{\frac{6 \cdot 8}{1 \cdot 7}} \times 5 = \frac{2 \cdot 6}{1 \cdot 3} \times 5 = 10 \text{ ft. per sec.}$$

Example III (*a*).—If we have a velocity of 20 feet per second in an airway, 625 yards long, with a water-gauge of 2 inches, what velocity would be obtained if the airway was increased in length to 1024 yards, water-gauge the same?

Answer.—Velocities with a fixed water-gauge vary inversely as the square roots of the resistances:—

$$\therefore V = \sqrt{\frac{625}{1024}} \times 20 = \frac{25}{32} \times 20$$

$$= \cdot 7812 \times 20 = 15 \cdot 624 \text{ velocity in ft. per sec.}$$

(*b*) Again, suppose we have a velocity of 15·624 feet per second in an airway, 1024 yards long, with 2 inches water-gauge, what would be the velocity if it was decreased in length to 625 yards?

This is exactly the reverse of the other:—

$$\therefore \quad V = \sqrt{\frac{1024}{625}} \times 15{\cdot}624 = \frac{32}{25} \times 15{\cdot}624$$

$= 1{\cdot}28 \times 15{\cdot}624 = 19{\cdot}99872$, say 20ft. as before.

The slight deficiency here is owing to decimal points (in the previous example) being only taken to four places, but for all practical purposes it shows the correctness of the rule. Students should work out in full the examples given and other similar ones, as by doing so they will prove for themselves the truth of the above law.

I wish to remind the student here, that in the same airways quantities may be substituted for velocities. The reason why they can only be substituted in the same airways is that if we had a velocity of 6 feet per sec. in an airway, 10 feet by 6 feet, the quantity would be: A $(10 \times 6) = 60 \times 6 \times 60 = 21600$ cubic feet per minute. Suppose the resistances offered were lessened to such an extent as to make the velocity 10, with the same airway, the quantity would equal $(60 \times 10 \times 60)$ 36000. But if we had a different airway, say 10 feet by 10 feet, this would equal $(100 \times 10 \times 60)$ 60,000 cubic feet per minute. It may be seen from the above that quantities cannot be substituted for velocities when different airways are taken, but only in the same airways.

Example.—If we have 10,000 cubic feet of air per minute passing through an airway, 1,225 yards long and 10 feet by 5 feet, with a water-gauge of ·368 inches, what amount of air would pass through if it was reduced in length to 900 yards, water-gauge the same ?

Answer.—The quantities in the same airways vary as the square roots of the resistances inversely:—

$$\therefore \quad \sqrt{\frac{1225}{900}} \times 10000 = \frac{35}{30} \times 10000$$

$$= 11{,}666{\cdot}6 \text{ cubic feet per minute.}$$

To prove the above, work out according to "Atkinson," and we have the following:—

1st.—Find the pressure to pass 10,000 cubic feet of air per minute in the airway, 1,225 yards long and 50 feet area:—

$$\text{Rule} \quad P = \frac{K\ S\ V^2}{A} \qquad K = {\cdot}0217$$

In this case—

$$A = 50 \quad S = (30 \times 1225 \times 3) = 110{,}250$$

$$V = \frac{10000}{50} = 200 \quad V^2 = \left(\frac{200}{1000}\right)^2 = 2 \times 2 = {\cdot}04$$

$$\therefore \quad P = \frac{{\cdot}0217 \times 110250 \times {\cdot}04}{50} = \frac{95{\cdot}697}{50} =$$

$1{\cdot}9139$ lbs. pressure required.

$$WG = \frac{1{\cdot}9139}{5{\cdot}2} = {\cdot}368$$

2nd.—Find the velocity in the airway when it is reduced to 900 yards long, pressure the same, $1{\cdot}9139$:—

S in this case equals $(900 \times 3 \times 30)$ 81,000.

$$\text{Rule} \quad V^2 = \frac{P\ A}{K\ S}$$

$$\therefore \quad V^2 = \frac{50 \times 1{\cdot}9139}{{\cdot}0217 \times 81000} = \frac{95{\cdot}695}{1757{\cdot}7} = {\cdot}05443$$

This number is the velocity squared in thousands of feet, therefore, to obtain the velocity we must take the square root of this number and multiply it by 1000, and this multiplied by the area gives the quantity:—

$\sqrt{{\cdot}05443} = {\cdot}23333 \times 1000 = 233{\cdot}33\ V \times 50 = 11666{\cdot}5$ cu. feet per mim., same as before.

(*To be continued.*)

COMPETITION QUESTIONS.

No. 18 SET.

TO the sender of the best set of Original Answers in each Stage will be awarded the following:—

Elementary 2s. 6d., Advanced 3s. 6d., First-Class 4s. 6d.

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2.—To be written on separate sheets of paper with name attached, and on one side of the paper only. Sketches to be in ink (Indian ink preferred) on *unruled* paper.

3.—Correct name and postal address must be sent.

4.—They must reach us by June 28th, 1895.

5.—The Editor's decision as to winners to be final.

ELEMENTARY.

Question 1.—Describe a simple method of boring for coal, and state how the section is recorded when solid cores are not obtained.

ADVANCED.

Question 2.—Describe briefly by means of sketches how levels are timbered in steep seams ?

FIRST-CLASS.

Question 3.—A colliery with a hundred hewers in a shift is ventilated by a current of 150,000 cubic feet per minute. Draw a sketch of bord and pillar, and longwall working for it, showing number of workmen in each district, the coarse of the air splits, stoppings, &c., and give proper dimensions for return airways, also quantity of air in each split.

EXAMINATION QUESTIONS ANSWERED.

By a First-Class Certificated Manager.

Questions given at the Manchester Examination for Second-class Certificates of Competency, Dec., 1894.

I.—Arithmetic.

Q. 1.—How many cubic inches are contained in a box 2 feet 5 inches long, 1 foot 2 inches wide, and $6\frac{1}{2}$ inches deep? (3 marks.)

A.—2 feet 5 inches = 29 inches, 1 foot 2 inches = 14in. Cubical content = $29 \times 14 \times 6\frac{1}{2}$ = 2639 cubic inches.

Q. 2.—What are the weekly wages of a collier who gets 24 tons 6 cwt. of coal, at 1s. $9\frac{1}{2}$d. per ton., and is paid for four yards of driving at 3s. 3d. per yard after paying his drawer five days' wages, at 4s. 10d. per day? (3 marks.)

	£	s.	d.
A.—24 tons, at 1s. $9\frac{1}{2}$d. per ton = 24 × 1s. $9\frac{1}{2}$d. =	2	3	0
6 cwt. = $\frac{6}{20}$ of a ton, and $\frac{6}{20}$ of 1s. $9\frac{1}{2}$d. = ...	0	0	6·45
4 yards at 3s. 3d. per yard = 4 × 3s. 3d. = ...	0	13	0
Wage of collier & drawer =	2	16	6·45
Wage of drawer = 5 × 4s. 10d. = ...	1	4	2
Wage of collier = ...	1	12	4·45

Q. 3.—Add £273 19s. 6d., £6 13s. $2\frac{1}{4}$d., and twenty-eight pounds seventeen shillings and fourpence together; subtract £154 2s. 8d. from the total and divide the remainder by thirteen? (3 marks.)

	£	s.	d.
A.—	273	19	6
	6	13	$2\frac{1}{4}$
	28	17	4
	309	10	$0\frac{1}{4}$
	154	2	8
	£155	7	$4\frac{1}{4}$

£155 7 $4\frac{1}{4}$ ÷ 13 = £11 19s. od. $\frac{9}{16}$

Q. 4.—How many 4-feet rails are required to lay a tramway 120 yards long, what is their weight (cwt., qrs., and lbs.) at 16lbs. to the yard? (3 marks.)

A.—Tramway, 120 yards long, requires 120 × 2 = 240 yards, or 240 × 3 = 720 feet of rails. 720 feet will require—

$$\frac{720}{4} = 180 \text{ 4-feet rails.}$$

240 yards of rails at 16lbs. per yard = 240 × 16 = 3840 lbs. 3840 lbs. = 34cwt., 1 qr., 4 lbs.

II.—Coal Mines Regulation Act, 1887, and Special Rules.

(N.B.—No answers have been given to these as readers can easily find them for themselves.)

Q. 5.—In addition to the examination of safety lamps required by General Rule 10, what is laid down in the Special Rules of this district as to examinations by the fireman? (4 marks.)

Q. 6.—What are the duties of the banksman of a sinking pit respecting the banking wagon, the hoppit or tub, and the sending down of materials? (4 marks.)

Q. 7.—If a shot misses fire what ought to be done (*a*) if an electric battery has been used (*b*) if other means of firing have been used? (4 marks.)

Q. 8.—What is the duty of a fireman in case he finds on his examination that any part of the mine is unsafe? (4 marks.)

Q. 9.—What precautions do the Act and Special Rules require to be taken upon approaching old workings suspected to contain gas or water? (4 marks.)

Q. 10.—State fully the provisions of the General and Special Rules with regard to propping and spragging? (4 marks.)

Time allowed for above paper, two hours.

III.—Practical Working of Mines.

Q. 11.—What are the chief causes of boiler explosions? (6 marks.)

A.—The chief causes of boiler explosions are insufficient water, incrustations, accumulated pressure, flues collapsing, and working at too high a pressure. If the water is allowed to get too low, the small quantity of water remaining in the boiler may assume a spheroidal condition, and when the heat decreases the water will suddenly burst into steam and cause an explosion. Again, if the feed-tap is turned on the water is immediately turned into steam and the safety valve cannot pass the steam away quick enough to prevent an explosion. Internal incrustations on the

boiler plates cause them to become red hot, and the incrustations may then separate from the plates and allow the water to reach them, thus generating a large quantity of highly elastic steam. The plates which have become red hot are considerably weakened, and these are the ones which are likely to give way. The pressure may accumulate above the ordinary safety pressure from several causes. The safety valves may be too small or get jammed in their seat, and if the steam is not being used quickly enough the pressure will rise above the working pressure of the boiler. The flues of a boiler occasionally collapse, the principal cause being faulty construction, or possibly incrustations on the exterior. Working at too high a pressure is perhaps the principal cause of boiler explosions. Boilers are made to work up to a certain pressure, and some persons are evidently of opinion that the boiler, no matter how long in use, should be able to withstand this pressure, instead of allowing for wear and tear. Others wishing to get as much work out of a boiler as possible have loaded it to more than they were given to understand it should work, and an explosion has been the result.

(To be continued.)

THE SOUTH WALES COALFIELD.

Specially prepared for "Mining" by a South Wales Contributor.

Geological and Descriptive.

THE South Wales Coalfield is one of the most important in the United Kingdom. It lies in the form of an oval trough, practically east and west, with a maximum length, from Abersychan to St. Bride's Bay, of 89 miles, and a width in Glamorganshire of 21 miles. Its area is computed roughly to be 1,000 square miles, 150 of which are underneath the sea, and one square mile is covered by newer formations. Half of its area is in the County of Glamorgan, and the remainder is distributed amongst the counties of Monmouthshire, Brecknockshire, Carmarthenshire, and Pembrokeshire, the area in the latter county being only 80 square miles. An anticlinal axis running east and west divides the coalfield into a northern and a southern basin, and brings the seams in the centre of the field within a workable depth. The axis can be traced from Meddart in Monmouthshire, through Pontypridd and Tonyrefail, across the lesser Ogmore, past Maesteg Iron Works, and through Baglan into Swansea Bay. Another axis is found to exist in the Pembrokeshire portion of the coalfield. The coal measures generally lie on the Millstone Grit, which in turn rests on the Mountain Limestone. The total thickness of the Millstone Grit is 220 feet, and at its base is found a stratum of conglomerate about 20 feet in thickness, which is often mistaken for the Farewell Rock lying at the base of the lower coal measures. West of Swansea Bay the Millstone Grit is absent, and the coal measures rest directly on the Mountain Limestone; further west the Mountain Limestone also disappears, and the coal measures rest on Lower Silurian Strata. Under the Mountain Limestone is the Old Red Sandstone, which where exposed is seen to dip conformably with the coal measures with a few exceptions, notably at Castell Coch where it dips south. The average thickness of the Old Red Sandstone is 800 feet. The coal measures are supposed to attain a thickness of 7,000 feet, and are divided into three series, viz., Upper Pennant, Lower Pennant, and the White Ash series. The Upper Pennant series is 3,000 feet thick on the southern rise, but only 400 feet in the southern trough. On the eastern side of Glamorganshire it averages 600 feet, except between the Dyffryn and Rhydding faults where it is 1,500 feet thick. The Lower Pennant series range from 1,100 to 1,500 feet and include all the measures between the Graigola, Mynydd-Isslyn and Llantwit seams, and the Cockshot Rock. This Cockshot Rock, or South Wales Pennant as it is sometimes called, is a stratum of silicious quartzose sandstone of variable thickness, and is identical with the Pennant Rock of the Bristol and Somerset coalfields. It forms in South Wales a natural boundary between the Upper and Lower Pennant, and the White Ash or Steam Coal series. The White Ash series is the most valuable group of all by reason of the great number and thickness of the seams of coal and argillaceous ironstone that are found in it. It attains a thickness of 1,000 feet in the centre of the field, but thins out to 500 feet on the eastern edge. Generally speaking more seams are met with on the southern crop, they are also of greater thickness. What is known as the Farewell Rock forms the base of the White Ash series, and the lowest stratum of the coal measures. In it occur the Rosser Veins of ironstone and several thin seams of coal. Marine fossils

have been found in it at some places clearly indicating its origin. The number of seams in the measures of this coalfield and the total thickness is greater than any other in this country. In the Upper and Lower Pennant series on the eastern side of the field there are 26 seams over 2 feet thick, giving an aggregate thickness of 100 feet, and on the western side 82 seams, with a total of 182 feet of workable coal. The working thickness of the White Ash series may be taken as 50 feet, and this includes the celebrated Aberdare upper 4 feet, 6 feet, and 9 feet seams. There are a number of large slip faults crossing the coalfield in a N. W. and S. E. direction, and with a few important exceptions are parallel to each other. The general hade is about 45°, but the lateral width is small, being from 8 to 15 yards. Smaller troubles, known as rolls, occur frequently, more particularly in the House Coal Seams. These do not cut out the whole thickness of the coal, but reduces it materially. A few washouts occur, notably one in the Rhondda Valley in the No. 3 Rhondda Seam. A peculiarity of the coalfield is the manner in which the cleavage or "slips" in the coal occur. They are from 9 to 18 inches apart with an underlie west of about three-fourths the height of the coal, and bear N. 30 W. (true meridian), about the same as the main faults. They are with two exceptions remarkably regular over the whole of the coalfield. These exceptions when they underlie east are called "backs," and in the Rhondda Valley, where there exist local disturbances parallel to the anticlinal axis, the slips have run in a diagonal course midway N. 30 W. and N. 80 W., the latter being the bearing of the disturbances.

Another peculiarity of the coalfield is the gradual change in the nature of the coal in passing from one side to the other, the same seam being bituminous in the east, semi-bituminous in the middle and highly anthracitic in the west. The change also takes place in a vertical plane, the upper seams being more bituminous than the lower. It has been stated that the change takes place in a plane dipping S. E., and from the circumstances prevailing in the Swansea valley, where both anthracite and semi-bituminous coals are worked from the same shaft, this appears to be highly probable. The writer has also noticed that in the same seam the amount of volatile matters increases in proportion to the distance from the anticlinal axis, until of course the effect of the outcrop is felt.

The following are actual analysis as made by the writer of the three distinct varieties of coal worked :—

	Anthracite. Big Vein.	Semi-bituminous or Steam Aberdare Upper 4 feet.	Bituminous or House, No. 3 Rhondda.
Carbon.........	92·27	88·77	85.72
Hydrogen ...	3·58	4·58	4·73
Oxygen and Nitrogen	1·80	3·14	3·52
Sulphur	·68	0·72	·87
Ash	1·67	2·04	4·30
Water	...	0·75	·76
	100·00	100·00	100·00
Volatile Matters		15%	25—30%

The Upper 4 feet Seam has obtained a world-wide reputation as a steam coal, the Admiralty classing it one of the first on their list. Its specific gravity is 1·3, calorific power 7·75, it gives 8·33 total heat units (Favre and Silbermann), and evaporates 14·4 lbs. of water per lb. of coal. It may be described as being of a somewhat bituminous nature, but burning freely and leaving little clinker. It is practically smokeless, very free from brass and shale, generates steam quickly in any climate, and is well adapted for storage in high latitudes. It stands shipment well and is economical in use, the small made in transit burning more readily than the large of many of the more anthracitic coals. No case of spontaneous combustion has been heard of with this coal.

Coke making is carried on extensively in South Wales. The No. 3 Rhondda Seam makes a first-class coke, some samples being quite equal to the best Durham. Although the quantity of volatile matters in the steam coals is small, viz., 14 to 15 %, it is found that in the Belgian type of oven after washing and crushing they yield a very fair furnace coke. The Coppee oven seems to give the best results, and is finding favour rapidly. The average yield of coke is 82 %, and it contains from 5 to 7 % of ash, and ·8 % of water. Some of the lower steam coals have been found to contain an abnormally high percentage of phosphorus, which proves a serious obstacle to the utilisation of the small for coke making.

The strata of the Upper and Lower Pennant series contain large quantities of water, and the enormous feeders met with in sinking are very difficult to deal with owing to the porous nature of the strata. Tubbing

is of little use, and there are only two instances of its application in the whole of the field. The feeders generally occur above the No. 3 Rhondda seam, the steam coals being practically free from water, except near the anticlinal. In the shallow pits it is a common occurrence to have operations suspended during wet weather owing to the influx of surface water. The stoppage of pumping operations in one of the larger collieries invariably means ruin to all the smaller pits for two or three miles around. The fiery character of the steam coals has been unfortunately proved too often, and more explosions are said to have occurred in the 4 feet seam than in any other known to the mining world. It is found in practice to yield more gas than any of the other steam coals, although analysis prove that the quantity of occluded gas is higher in the 6 feet seam. The main portion of the gas exudes from the freshly cut surface of the coal, but strong jets or blowers are also found in coal, roof, and floor, and these often necessitate the stoppage of a district for days together. The pressure at which the gas exists in the coal reduces the labour of cutting very materially, the coal often bursting out in large masses and requiring very careful spragging.

In the House Coal Seams but little gas is made, and naked lights are used in most of the collieries. In the Steam Coals locked safety lamps are exclusively used, and are chiefly of the bonneted Clanny type (Evan Thomas's modification) with the old screw lock. It has been noticed that the gas of the Welsh collieries contains a very large proportion of ethane as well as other hydrocarbon compounds. As these have a much lower temperature of ignition than ordinary CH_4, this may account in some measure for the frequency of explosions in the district.

The inclination of the seams is very variable the steam coals of the Rhondda, Aberdare, and Merthyr Valleys, having an average dip of 3½ inches per yard. As the anticlinal is approached, the inclination increases rapidly and may be anything up to 18 inches per yard. On the top of the ridge there is generally found a flat portion from 200 to 500 yards in width. In the anthracite district and on the southern outcrop of Glamorganshire, the seams dip sharply and in some cases are thrown on end. The upper seams are generally worked by rise and dip slants following the seam from its outcrop, or cross measure drifts which intersect one or more seams. The majority of the old pits have been deepened to win the steam coals, or to serve as ventilating and pumping shafts. They are of small size generally, elliptical in shape, and are seldom lined. It is now found better to sink new pits from the surface, which are made circular from 15 to 20 feet diameter in the clear, and bricked from top to bottom. The depth of the pits is not great as a rule, with the exception of one at Harris Navigation Colliery, which is 746 yards to the lowest seam.

(To be continued.)

EDITORIAL NOTES.

Modern Explosives.

The Managing Director (Mr. G. Beneké) of the Westphalite Explosive Syndicate, in a letter to the press, states that all experiments represented as having been made with their explosive in this country, other than those at the Ince experimental station, are utterly unreliable, as they have not yet supplied the explosive to any British colliery, and that the experiments have, therefore, not been made with their explosive. Noticing that the North of England have offered their experimental station to the Government, Mr. Beneké corroborates the statement which we made in No. 3 of the present volume, viz., that the small charges with which the apparatus alone can deal does not allow a correct estimate of the respective merits of the explosives being made. Powerful detonators, say No. 6, applied to charges of 1oz. to 2ozs. will not in our opinion give the same result as the same detonator applied to charges of from 4ozs. to 16ozs.

AWARDS

For Answers to Competition Questions—No. 15.

Elementary—Jos. Wheatcroft, 8, Longsight Terrace, Kinsley Hemsworth, near Wakefield.

Commended—T. Rimmer, J. Coates, R. Sleeman, T. Emmerson, T. Webster, F. Cherry, J. Finch, J. McCartney, H. Rhodes, W. Kehor, W. Curtis.

Advanced—T. E. Aitchison, Green Hill, Dunaskin, Ayrshire.

Commended—W. Wycroft, H. Hall, J. Crone, J. Stephenson, J. Jones, J. Eaves.

First-Class—No award.

Commended—J. Davies, Myles Brown, S. Davies, G. Daykin, T. Winlow.

EXAMINATION QUESTIONS.

(Newcastle District, 1894.)

FOR FIRST & SECOND-CLASS CERTIFICATES.

No. 1 PAPER.

Time allowed Five Hours.

N.B.—The working out of all questions must be fully shown. No answer giving simply the result will be accepted.

I.—ARITHMETIC.

1. Add together 361·1264, 8·351, 10·004, 136·28.

2. Substract 5 cwts. 1 qr. 10 lbs. from 6 cwts. 9 lbs.

3. Multiply $3\frac{3}{8}$ by $1\frac{81}{188}$

4. Divide 10,814,220 by 876.

5. Reduce 2 miles 1 furlong 21 poles $2\frac{1}{2}$ yards to inches.

6. Three men make a bargain for the sum of *l*250, one to have $\frac{3}{10}$, the second $\frac{3}{15}$ of it. What is the value of the third's share?

7. Find the value of 6,420 articles at 4s. $3\frac{1}{2}$d., and of 14,764 articles at £1 17s. $8\frac{1}{2}$d.

8. A field containing 19 acres 3 roods 34 perches was divided into 34 allotments. What is the area of each allotment? Express the result, as a decimal of an acre correct to five places.

II.—PUMPING.

1. The feeders of water in a pit are 700 gallons per minute, the depth of shaft 100 fathoms. Assuming the engine to be fixed upon the surface and to work six strokes per minute, how would you arrange the lifts, and what size would you make the pumps?

2. Sketch the different parts of a lifting and forcing set of pumps. Give the name of each part and explain how it acts.

III.—METHODS OF WORKING AND VENTILATION.

1. Sketch a district of bord and pillar workings with the broken following up the whole workings, so that you could employ 25 hewers in each shift, and have equal quantities coming from the whole and broken.

2. Sketch a longwall district for 26 hewers in a shift. In each case indicate the course of the ventilation by arrows, and show the position of all stoppings, regulators and doors.

IV.—TIMBERING.

1. Show by plan and section how you would timber a main engine plane with a bad roof.

2. Describe and illustrate by plan and section the method of timbering where a branch way leaves a main road at an angle of 90 degrees.

V.—BAROMETER AND THERMOMETER.

1. Describe the construction and use of the water-gauge, barometer, and thermometer.

2. Supposing you have two seams of coal in a shaft, one at a depth of 100 fathoms, and one at a depth of 250 fathoms. What will be the difference between the reading of the barometer in each seam?

VI.—MEASUREMENT OF AIR.

1. State all the methods you know of measuring the air passing through the gallery of a mine, and describe fully the two methods generally adopted.

2. What quantity of air will pass through a circular shaft 12 feet 5 inches diameter when the velocity of the air is 6 feet per second.

VII.—SAFETY LAMPS.

1. What is the principal of safety lamps and how are they safe?

2. Describe and illustrate with sketches any two of the following safety lamps, viz., the Davy, Clanny, Muesler, and Marsaut.

VIII.—EXPLOSIVES.

1.—Describe fully the process of drilling a hole and firing a shot, and state what precautions are necessary to avoid accidents.

2. Name the explosives you have been accustomed to, and state what arrangements you had for blasting under various circumstances.

IX.—COAL MINES REGULATION ACT.

State the regulations—

1. As to employment of boys between 12 and 16 below ground.

2. As to cases in which fencing is required.

3. As to examination of safety lamps.

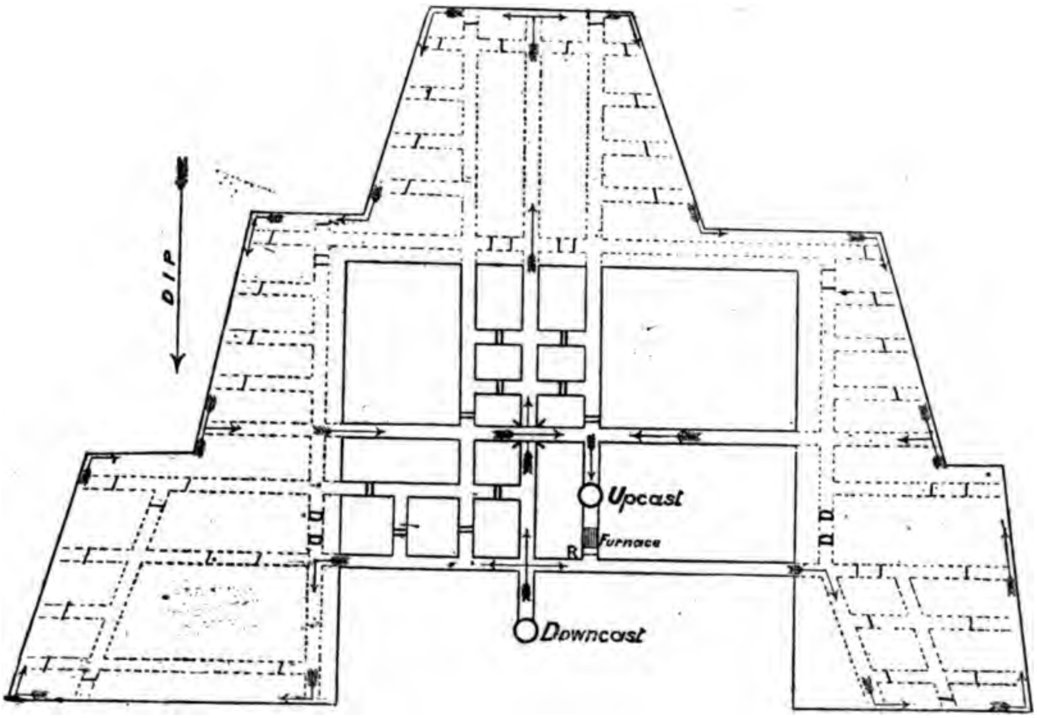
4. As to means of signalling in working shafts.

5. As to timbering.

No. 2 Paper for First-class Certificates will be given next issue.

VENTILATION PLAN.

Given at the Liverpool District Examination for First-Class Certificates of Competency.—1888.



CORRESPONDENCE.

Size of Engine Required.

Sir,—The following is a solution to J. P.'s question in regard to the above, which appeared in No. 11, Vol. III.:—

LOAD ON ROPE.

Coals	.... =	48 cwt.
Tubs	.... =	24 cwt.
Cages (⅔ wt. of coals)	=	32 cwt.
		104 cwt., or 11,648 lbs.

C = Circumference of rope in inches.
D = Depth of shaft in fathoms.
F = Factor of safety.
L = Load in tons.

$$C = \sqrt{\frac{L}{\frac{4}{F} - \frac{D}{1{\cdot}2 \times 2240}}}$$

$$C = \sqrt{\frac{5{\cdot}25}{\frac{4}{10} - \frac{300}{1{\cdot}2 \times 2240}}} = C = \sqrt{\frac{5{\cdot}25}{{\cdot}4 - {\cdot}11}} = C = \sqrt{18}$$

C = 4ft. 2in., then $C^2 \times {\cdot}9 \times$ depth in fathoms = weight of rope in lbs.

$4{\cdot}2 \times 4{\cdot}2 \times {\cdot}9 \times 300 = 5292$ lbs., weight of rope.

Take 10 feet as minimum diameter of drum for a rope 1in. in circumference, and add 6in. to dia. of drum for every additional ¼in. of rope. Therefore, drum = 16 5 feet dia.

$16{\cdot}5 \times 3{\cdot}1416 = 51{\cdot}8354$ ft., dia. of drum.

$\frac{600 \times 3}{51{\cdot}8354} = 34{\cdot}7$ revs. of eng. Steam cut off at 27 revs.

Take 6 feet, length of stroke.

Load on engine = 5376 lbs. of coal + 5292 lbs. weight of rope = 10,678 lbs.

$10{,}678 \times 600 \times 3 = 19{,}220{,}400$ units of work.

$\sqrt{\frac{19220400}{{\cdot}7854 \times 75 \times 6 \times 2 \times 27}} = 31{\cdot}7$ in., dia. of cylinder.

Say useful effect, 50%, two cylinders will be required.

SUMMARY.—Coupled horizontal engines; cylinders, 31·7in. dia., length of stroke, 6ft., making 34·7 revs.; steam cut off at 27 revs.; size of rope, 4ft. 2in. cir.; dia. of drum, 16·5 feet; pulley, same dia. as drum; four tubs per cage, carrying 12cwt. of coal; tubs, 6 cwt. each; cage, 32 cwt.; steam pressure, 75 lbs.; useful effect, 50%.

D. JACK.

Ventilation Query.

Sir,—I should be glad if some reader of your valuable journal would assist me in answering the following question with full details:—A return air-current of 10,000 cubic feet per minute contains explosive gas in the proportion of 1 of CH_4 to 13 of air. What is the least volume of air per minute which must be added to the current to prevent its showing a cap?—DEPUTY.

ANSWERS TO QUESTIONS.

No. 15 Set—In No. 12, Vol. III.

ELEMENTARY.

Question 1.—How is the forebreast of a level ventilated?

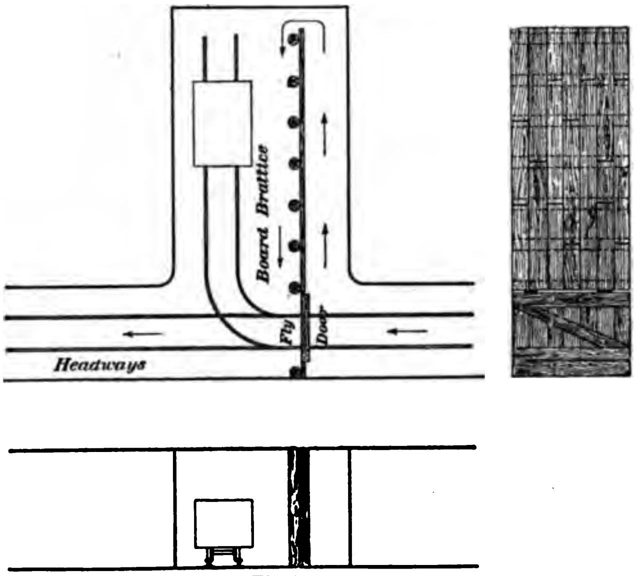


Fig. 1.

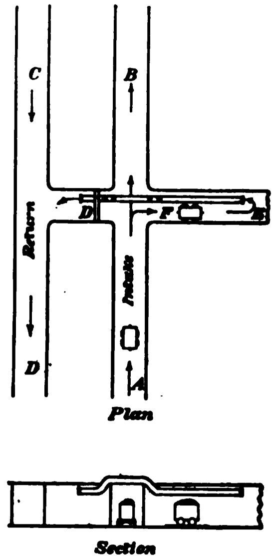


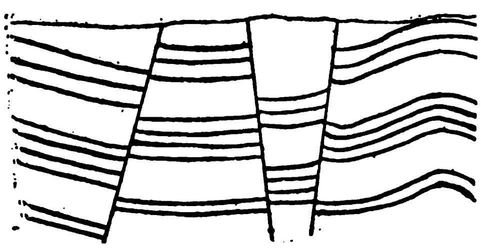
Fig. 2.

Answer.—The forebreast of a level may be ventilated by means of a partition of brattice cloth running along or near the centre of the level. It is suspended from the roof by means of bars of wood, about 7 inches broad, 2½ inches in depth, and from 10 to 16 feet in length, these are supported by props set about 6 feet apart. The air enters along one side of the brattice and returns along the other. If the level is comparatively short, and only a small quantity of gas is given off, cloth brattice may be sufficient, but for more perfect ventilation board brattice (fig. 1) should be used. This is fixed in the same manner as the cloth brattice, but forms a more permanent partition. For single roads of considerable length, such as those driving to open out new workings, the best partition is a wall of bricks and mortar. Sometimes pipes of wood or iron are used for ventilating the ends of workings (fig. 2), and they are suitable for carrying the air considerable distances, providing the quantity required is small.

JOSEPH WHEATCROFT.

GENERAL STRUCTURE OF A COALFIELD.

Question 2.—Describe the general structure of a coalfield.



Answer.—The seams of a coalfield are rarely found level or horizontal, but are generally inclined at various angles between the horizontal and the vertical. Whatever happens to one bed the others are affected somewhat similar, owing to coal seams being parallel to the stratification of the rock beds above and below. Owing to this inclination seams are found in some parts of the country cropping out at the surface, whilst in other parts they are found at a considerable depth from the surface. Fortunately, the coal measures, as a whole, in this country lie more or less horizontally, at any rate, at an easy angle of inclination, many of them occurring in a basin-shaped depression. Beds or seams of coal do not dip at the same angle for any considerable distance, but are found to vary a great deal in a small area. Sometimes

they dip for a certain distance and then begin to rise, thus forming a basin. At other times they rise and then dip, thus forming what is termed a saddle or anticline. Seams seldom continue (over long distances) of the same character throughout, but they frequently become changed in thickness, quality, hardness and composition. Clay bands may appear, thicken, or disappear. Originally the beds were deposited in a continuous horizontal line, but owing to various movements of the earth's crust in former periods they have been fractured, and portions have been elevated and depressed in such a way that, instead of continuous beds, we find them detached and lying at different levels. It is very common in working a coal seam to find it suddenly terminated and stone appear in the place of coal, accompanied with indications of a fissure, filled with a solid mass of broken stone, extending upwards and downwards. This is termed a fault, and the continuation of the coal seam will be found at a different level, either above or below, on the opposite side. These occur so often in some seams that it is hardly profitable to work them. Other interruptions encountered in the working of mines might be mentioned, such as dykes, balks, rolls, nip-outs, swellies, and washes or wash-outs, all of which cause the winning of the coal to be more costly.

JOSEPH WHEATCROFT.

ADVANCED.

FIRES IN COAL MINES.

Question 4.—How do fires originate in coal mines, and what means are usually taken to extinguish them ?

Answer.—Some seams of coal are liable to spontaneous combustion, the first sign of which are given by a peculiar smell (fire stink), and this undesirable state of affairs is produced by three agencies:—(1) Oxidation of the organic constituents. (2) Iron pyrites. (3) Pressure. The first I believe to be the main cause, assisted of course materially by the other two.

(1) Oxidation of the organic constituents. The high importance of this action may be looked upon as being the most effective of the three. Coal absorbs oxygen, one part combining with the carbon and hydrogen, forming carbonic acid and water, while the others enter into combination with the coal. Before combustion coal, so inclined, emits large quantities of CO_2. Heating results from the absorption of oxygen, moisture, fine divisions, and absence of light, everything combined to favour decomposition. (2) Iron pyrites. When decomposing this substance yields first "firrous sulphate," and secondly "ferric sulphate;" the latter is of a brown colour and is more frequently observed, being produced by decomposition, and forms "sulphuric acid," and as the volume exceeds the original pyrites, disintegration of the coal is affected, and a little heat is given off. (3) Pressure. Pressure upon the pillars crack thems and grinds the irregular sides of the fissures together, thus producing heat and a large quantity of fine coal. Where slack and inferior coal is thrown into the gob in a finely divided state, it combines more readily with the oxygen in the air than when in large solid lumps, thus developing heat which causes it to smolder, till at length the temperature of the mass is so great that it bursts into flame. To prevent these fires and the dangers arising therefrom the following precautions should be taken. (1) Remove all fine slack and refuse. (2) A vigorous current of cool air should be kept circulating so as to cool the surface of the coal over which it sweeps. (3) Safeguard lines of water pipes should be laid from shaft tubbing at a high pressure, as high pressure water is invaluable at collieries liable to spontaneous combustion. "Wax walling" is sometimes resorted to. A wax wall is a wall of clay, and is built at the back of the gate pack, and every now and again they are continued across the gob from wall to wall, thus completely sealing off the air and obviating any chance of gob-fires breaking out. The reason why this plan is not more generally adopted in seams that are liable to spontaneous combustion is that it is an expensive one, and also because clay is not always conveniently at hand at the collieries where it is required. If the fire was already ignited and of an extensive nature there should be barriers or "clay dykes"—"wax walls" constructed and made air-tight round about the region of the fire. All passages or openings leading through the solid coal to the fire should be closely packed with clay and sand, or strong walls built with brick or stone and cement, and made tight in between with sand or clay. If the fire was in the dip workings I would drown the fire out.

THOMAS. E. AITCHISON.

Questions 3 and 5 have not been suitably answered. We will, therefore, repeat them, and as they appear to be a little difficult we will give double marks in the Gold Medal and other Competitions for them.—ED.

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MINING

A JOURNAL DEVOTED TO THE INTERESTS OF MINI…

No 16. Vol. III. SATURDAY, JUNE 29, 1895. FORTNIGHTLY. ONE PENNY.

CONTENTS. PAGE

EASY LESSONS ON

MINE VENTILATION.

By J. CARTER, First-Class Certificated Manager.

(COMMENCED IN NO. 9, VOL. III.)

THE third law of ventilation includes the following:—(I) Quantities vary as the cube roots of the powers. (II) The powers vary as the cubes of the quantities. From the above it will be seen that the third law of ventilation treats of the relationship of quantities to powers or powers to quantities in the same mine or airways. The following examples will illustrate and enable students to understand more clearly the above relationship of powers and quantities.

(I) Quantities vary as cube roots of the powers.

EXAMPLE 1.—Suppose we had 8 horse-power, and it produced a ventilation of 60,000 cubic feet of air per minute, what quantity of air would be produced with 27 horse-power.

In looking at this question we see clearly that a greater quantity will be produced because we have a greater power, but this increase will not be in the proportion of the powers as given but as the cube roots of those powers. Let—

$Q =$ Greater quantity $\quad P =$ Greater power
$q =$ Lesser ,, $\quad p =$ Lesser ,,

Then in the above example we have the following:—$P = 27$, $p = 8$, $q = 60{,}000$, $Q =$ quantity to be found. Therefore the solution may be represented thus:—

$$Q = \sqrt[3]{\frac{P}{p}} \times 60000$$

$$\therefore Q = \sqrt[3]{\frac{27}{8}} \times 60000 = \frac{3}{2} \times 60000 = 90000 \text{ cubic feet.}$$

Reverse the question and say, if we had 90000 cubic feet of air per minute with 27 horse-power, what amount should we have with 8 horse-power. In this case we should have a less quantity, because we have a less power.

$$q = \sqrt[3]{\frac{p}{P}} \times 90000$$

$$\therefore q = \sqrt[3]{\frac{8}{27}} \times 90000 = \frac{2}{3} \times 90000 = 60000 \text{ cubic feet.}$$

EXAMPLE 2.—If with 64 horse-power we produce 120000 cubic feet of air per minute, what quantity will be produced with 27 horse-power?

$$\text{Rule—}\quad q = \sqrt[3]{\frac{p}{P}} \times 120000$$

$$\therefore q = \sqrt[3]{\frac{27}{64}} \times 120000 = \frac{3}{4} \times 120000 = 90000 \text{ cubic feet.}$$

(II.) The powers vary as the cube of the quantities.

EXAMPLE.—If a ventilation of 60000 cubic feet of air per minute required 8 horse-power, what horse-power would 90000 cubic feet of air require? Here we should want a greater power, because we have a greater quantity in the following ratio:— $P = \frac{Q^3}{q^3} \times p$

$$\therefore \quad P = \frac{120000^3}{60000^3} \times 8 = \frac{12^3}{6^3} \times 8 = \frac{2^3}{1^3} \times 8$$
$$= 8 \times 8 = 64 \text{ H.P.}$$

Reverse this and say, if 120000 cubic feet of air requires 64 horse-power, what power will 60000 require? Rule— $p = \frac{q^3}{Q^3} \times P$

$$\therefore \quad p = \frac{60000^3}{120000^3} \times 64 = \frac{6^3}{12^3} \times 64 = \frac{1^3}{2^3} \times 64$$
$$= \cdot 125 \times 64 = 8 \text{ H.P.}$$

We will take another example. Suppose we had a ventilation of 80000 cubic feet of air per minute with a horse-power of 64, what horse-power would be required to produce 160000 cubic feet? Here we should require a greater power, because we have a greater amount of ventilation, therefore, the ratio would be thus:— Rule, $P = \frac{Q^3}{q^3} \times p$

$$\therefore \quad P = \frac{160000^3}{80000^3} \times 64 = \frac{16^3}{8^3} \times 64 = \frac{2^3}{1^3} \times 64$$
$$= 8 \times 64 = 512 \text{ H.P.}$$

When pressures and quantities are given the powers are determined as follows:—

Question 1.—A velocity of 840 feet per minute is obtained in an airway 6 feet high and 10 feet wide, with a water-gauge of 3·5, between the main intake and return at pit bottom. What is the horse-power expended on the underground workings—shaft friction not taken into account. A = 60, V = 840, W.G. = 3·5, H.P. = horse-power.

$$\text{Rule— H.P.} = \frac{V \times A \times \text{W.G.} \times 5 \cdot 2}{33000}$$

$$\therefore \quad \text{H.P.} = \frac{840 \times 60 \times 3 \cdot 5 \times 5 \cdot 2}{33000} = \frac{943280}{33000}$$
$$= 28 \cdot 6 \text{ nearly.}$$

Question 2.—If we had a ventilation of 140000 cubic feet of air per minute with a water-gauge of 2·5 in fan drift. Quantity measured in fan drift. Find horse-power:—

$$\text{H.P.} = \frac{140000 \times 2 \cdot 5 \times 5 \cdot 2}{33000} = 55 \cdot 15 \text{ H.P.}$$

The theory of ventilation may be summed up as follows:—(1) Resistance varies as the rubbing surfaces per square foot of section, and the pressure is equal to the resistance. (2) Friction varies as the squares of the velocities of the air-currents, and the velocities of air-currents vary as the square roots of the resistances. (3) Powers producing ventilation vary as the cube of the quantities and the quantities in air-currents vary as the cube roots of the powers. The following are the principal factors in determining the quantity of air passing in a mine:—

K = Co-efficient of friction.
S = The rubbing surface of the airways in square feet.
V = The velocity of the air-current.
A = The area of section of an airway.
P = The pressure per square foot producing ventilation.

Before going into the theory of splitting the air in mines I will here give various examples from questions that have been given at examinations for mine managers' certificates. The examples here given are based on the preceding laws on ventilation.

Question 1.—What is the horse-power expended in the ventilation of a mine when the quantity of air passing is 95,000 cubic feet per minute and the water-gauge is 3·75?

$$\frac{95000 \times 3 \cdot 75 \times 5 \cdot 2}{33000} = 56 \cdot 13 \text{ H.P.}$$

Question 2.—What additional ventilating power would be necessary to double the quantity of air without altering the airways?

Power necessary for increasing the ventilation increases as the cube of the velocity, so that in this case the power required would be—

$$\frac{2^3}{1^3} = 8 \text{ times original power.}$$

Therefore, additional ventilating power will be 7 times original power.

Question 3.—If it required 6 horse-power to circulate 25000 cubic feet of air in a mine, what horse-power must be employed to pass 45000 cubic feet through it? Airways to remain in the same condition. The power is according to the cube of the quantities. Then we say, if

$$25000^3 : 6 :: 45000^3 = 34 \cdot 9 \text{ H.P.}$$

Question 4.—If you have 120000 cubic feet of air per minute passing into a mine, at a temperature of 45° F., the temperature of the return at the bottom of the upcast shaft being 82° F., what is the volume of air circulating in the upcast per minute?

As air expands $\frac{1}{459}$ for every degree F., we should have a volume of air in the upcast shaft of 128809·5 cubic feet per minute.

Calculation shown thus:—

$$\left(\frac{459+82}{459+45}\right) \times 120000 = \frac{541 \times 120000}{504} = 128809\cdot5 \text{ cubic feet.}$$

Question 5.—If a fan, running at 80 revolutions per minute, generates a current of 100000 cubic feet of air per minute, with a water-gauge of 2·7 inches, what will be the horse-power of the air? If the quantity be increased to 140000 cubic feet per minute, what will be the water-gauge, the horse-power in the air, and the number of revolutions of the fan?

$$\text{H.P.} = \frac{100000 \times 2\cdot7 \times 5\cdot2}{33000} = 42\cdot54$$

$$\text{W.G.} = \frac{140000^2 \times 2\cdot7}{100000^2} = 5\cdot292$$

$$\text{H.P.} = \frac{140000 \times 5\cdot292 \times 5\cdot2}{33000} = 116\cdot74$$

Or as the power increases as the cube of the quantity we can apply the following:—

$$\frac{140000^3 \times 42\cdot54}{100000^3} = 116\cdot74 \text{ as before.}$$

As the volume of air produced varies with the speed of the fan if other conditions remain constant. Thus—

100000 : 80 :: 140000 : 112 revolutions.

Therefore—

H.P. for 100000 with 2·7 W.G. = 42·54
H.P. for 140000 with 5·292 „ = 116·74
W.G. for 140000 = 5·292
Revolutions of fan for 140000 = 112.

(*To be continued.*)

THE SOUTH WALES COALFIELD.

Specially prepared for "Mining" by a South Wales Contributor.

CONTINUED FROM LAST ISSUE.

Winning and Working.

THERE are three methods of working practised in the South Wales coalfield, viz., longwall, single stall, and double stall. Prior to the development of the steam coals, the two latter methods were exclusively employed, but their use is now confined to a few of the house coal seams. It is found that they are only applicable in seams with a strong rock top; and with the friable clift roof of the steam coals are quite out of the question. The 9-feet seam, which is an exceptionally thick one, and the Black Vein have been worked a little by double stall, but longwall has now superseded it. It is recognised as a first principle in South Wales that under clift roof every bit of coal must be extracted except the shaft pillar; also the face must be kept advancing as rapidly as possible, and care taken that no portion of it lags behind the rest, as it inevitably causes the roof to fracture in all directions. In the house coal seams, where the top is generally strong rock, it is often found advantageous to leave pillars to protect the main roads, but in the majority of cases they are left too small to be of any service. Figure 1 shows the

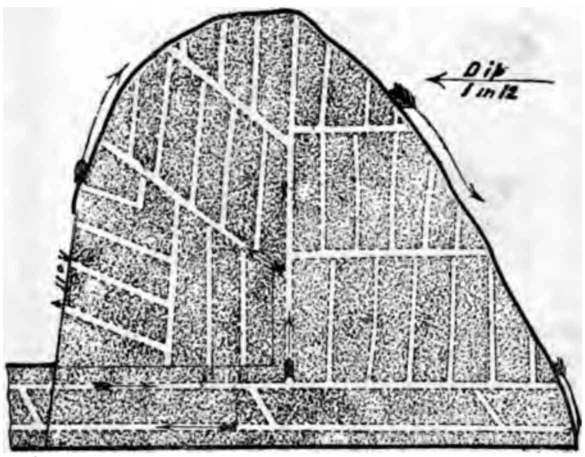


Fig. 1.

method of working the steam coals by longwall, and is reduced from the working plan of a Rhondda colliery. The seam is the

Upper 4-feet. The roof is very rotten and a good deal of gas is made. The section is shown by fig. 2, with the method of securing

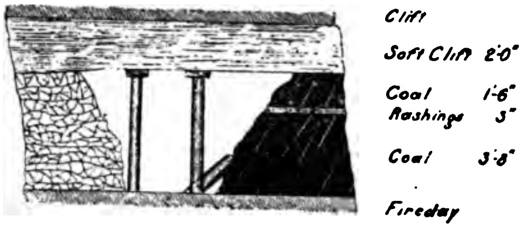


Fig. 2.

the face. The general practice is to drive a pair of winning headings to the full rise and dip of the seam. Levels are turned from these every 200 yards, and the cutting-off headings driven at intervals of 44 yards, with level stalls 15 yards apart. Winning headings are driven 15 yards apart, with 6 yards gob on each side. It is found that the roads stand better when driven this way than if they had the solid on one side. To support the face, one or two rows of posts are used, and sprags where they are required. The roof in the roads is supported by posts and flats until the permanent timbering is put in. Cogs are placed at the corners of all roads and wherever the squeeze is great. In some of the deeper pits cogs are constructed of hard Pennant Sandstone taken down from the surface. These are only placed where everything else has failed, and are found to

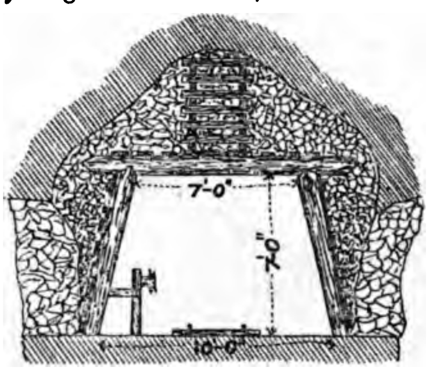


Fig. 3.

support a tremendous weight without crushing. Packwalls or pins are built along the sides of all roads with cross and intermediate pins at intervals. All the old roads and the gob are stowed solid, as there is great difficulty experienced in dealing with the rubbish, a large quantity having to be wound at night. Three rippings are generally made in the main roads before the permanent timbering is put in. This has to be done in a very substantial manner to stand the heavy side weight that generally prevails. The usual collar and arms are used, but they are invariably inclined and notched in the Welsh style. With heavy side pressure the collar is notched deep and a large face made on the arm. The reverse has to be done to resist top pressure, and the arms are then placed as vertical as is practicable. It generally happens that both top and side weight have to be provided against, and fig. 3 shows the arrangement of timbering a main haulage road for main and tail rope under these circumstances. When there is a large cavity in the roof a cog is built up from the laggings to prevent the collar from rising, or an iron dog is used, binding it down to the arms. Fig. 4 shows the arrangement of timbering a

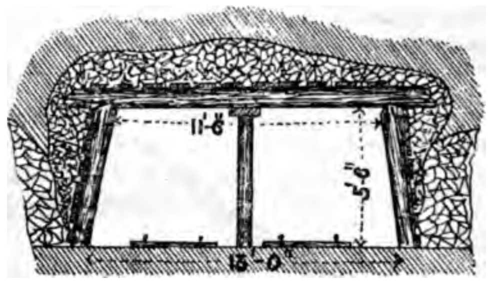


Fig. 4.

double parting where extra width is required. All the roads are driven of sufficient size to allow a horse to travel on them, and the top is ripped or the bottom cut in the stalls wherever necessary.

The ventilation of the steam coal is a comparatively easy matter in most of the pits and is generally very good. The returns are often driven in the gob, but are then very difficult to maintain. Temporary air-bridges are constructed of wooden beams resting on brick sidewalls, and after the ground has settled, a length of arching is turned and the return air carried over the top. For ventilating narrow places or cross measure drifts sheet-iron air-pipes are always used, and in some cases are connected with a small fan worked by compressed air.

In most of the large collieries the main roads are usually very dry and dusty. This is partly due to the friable nature of the coal, but the open-ended trams in use, with the coal piled up over the top, contribute greatly to the deposition of dust. Elaborate arrangements for watering are in practice in many of the collieries, both water alone and in conjunction with compressed air being

used. The following are a few particulars of an installation working in a Rhondda colliery, raising 2,000 tons per day:—

	Yards.	
Length of Pipes in shaft	475	4in. dia.
Length of Pipes underground.	10,434	1¼in. dia.
Total Length......	10,909 = 6¼ miles.	

The water is supplied from the colliery reservoir, and the pressure due to the head after taking it down the pit is found to produce a very efficient spray. The number of sprays is 250, of which about two-thirds are of the single-hole pattern and the rest are roses, the former being found to answer best. There are thirty 1½ inch cocks for regulating the supply to different sections of the mine. The approximate distance the sprays are set apart is 35 yards. The system is only in use between the shifts, as the riders and hauliers on the main roads object to work in the spray.

cotter. In the steam coal seams, wheels fastened on the axle are found to answer best and are usually about 13 inches diameter on the tread. In the house coal seams where the roads are undulating and wind about loose wheels have to be used, but the tendency is to adopt the fast type almost everywhere. The rails used in stall roads are of the bridge section, weighing about 22lbs. per yard, made in 9-feet lengths and secured to the sleepers by two nails. On the main roads flange rails are used of 30lbs. per yard, fastened down by dogs and the joints fished. Partings are generally made in cast-iron and steel sleepers are extensively used.

In the Upper seams the appliances are of a rougher type and the working is slightly different to that of the steam coals. A method of working, commonly used in the house coal and the Anthracite district, is shown in fig. 5, which illustrates the working

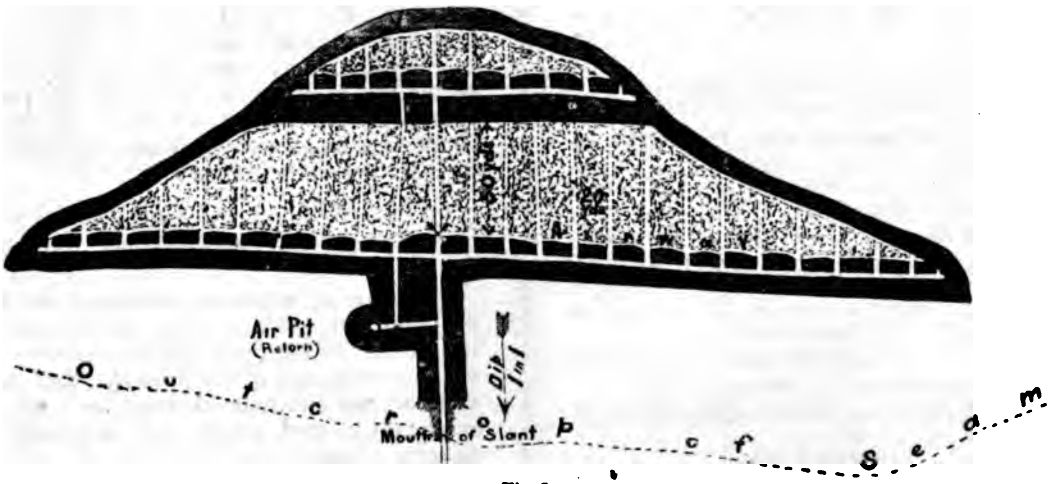


Fig. 5.

The system of haulage chiefly adopted is main and tail, or main rope alone where the gradient is suitable. A little endless rope haulage is at work chiefly around the shaft bottoms and in "slums." Compressed air is the general motive-power, and is used at about 45lbs. pressure. The engines are generally fixed on beams or girders, placed across the road and arched over. They are of the self-contained type, geared about 4 to 1. The journeys are run at a speed of from 10 to 15 miles an hour, the number of trams depending on the gradient, and being 25 to 30 on a level road. The trams are of iron, with the sides bulged out at the top, and carrying from 20 to 50 cwt. One end is plated and the other has two movable round iron bars placed across it, which are secured by a

of an outcrop seam on a mountain side. The single and double-stall methods are still in use, but are gradually being abandoned. There is little to be said in their favour, as they are wasteful in working, difficult to ventilate, and quite impracticable in seams with a bad roof. The best way to work the Upper seams is that shown in fig. 5, with water-levels driven off the main slant every 60 yards, and rise stalls or top-holes turned. These top-holes are only made to the height of the seam and, with inclinations up to 20 inches per yard, the coal is brought down them in an iron-shod sledge. When the inclination exceeds 20 inches per yard the floor of the top-hole is laid with iron plates and a slide fixed at its lower end. It then becomes a shoot, in which the coal

runs down from the face to a tram on the level. To prevent accidents in the highly-inclined seams the face is kept stepped, and in the Anthracite district the coal is worked on the face or backs to reduce the labour of cutting.

The surface arrangements and mechanical details in South Wales collieries are very good, and labour-saving appliances are being rapidly adopted. To attempt to describe any of these would take up too much space and hardly comes within the scope of this article. The foregoing brief sketch may, however, prove of some little service to South Wales readers, as little has hitherto been written on the coalfield.

(*Concluded.*)

COMPETITION QUESTIONS.

No. 19 SET.

To the sender of the best set of Original Answers in each Stage will be awarded the following:—

Elementary 2s. 6d., Advanced 3s. 6d., First-Class 4s. 6d

A Competitor may only answer one Stage. The best answer to each question will be published with the sender's name and address.

1.—All envelopes must be marked "COMPETITION."

2.—To be written on separate sheets of paper with name attached, and on one side of the paper only. Sketches to be in ink (Indian ink preferred) on *unruled* paper.

3.—Correct name and postal address must be sent.

4.—They must reach us by July 12th, 1895.

5.—The Editor's decision as to winners to be final.

ELEMENTARY.

Question 1.—State clearly what is meant by the specific gravity and symbol of a gas. Of what use is a knowledge of these?

Question 2.—How are bits and borers tempered and sharpened for boring by hand?

ADVANCED.

Question 3.—Explain the theory of the ventilation of mines, and why artificial ventilation is more reliable than natural?

Question 4.—Describe the Pieler and Clowes methods of testing for gas?

FIRST-CLASS.

Question 5.—Describe and illustrate the usual surface arrangements for diamond boring?

EXAMINATION QUESTIONS ANSWERED.

By a First-Class Certificated Manager.

Questions given at the Manchester Examination for Second-class Certificates of Competency, Dec., 1894.

III.—Practical Working of Mines.—Contd.

Q. 12.—What are the principal causes of accidents in mines? Give shortly the precautions necessary to avoid them. (6 marks.)

A.—The principal causes of accidents are falls and explosions. The precautions to be taken to avoid the former are to take the greatest possible care in timbering, and to draw up a stringent code of rules for the guidance of the workmen, to the effect that props and sprags should be set at not less than a definite distance apart, and oftener where it is thought necessary. The following precautions should be taken to avoid an explosion. Use a good type of safety lamp, keep the ventilation good, water main roads in a dry and dusty mine, strictly enforce the requirements of the C. M. R. A., use one of the safety explosives, and cease shot-firing, if practicable, except when the general workmen are out of the mine.

Q. 13.—What are the signs generally observed in approaching old workings? (6 marks.)

A.—The signs usually observed are that coal and roof are frequently broken and discoloured; at intervals breaks occur in the roof and coal, and it is "winded," that is to say the gas has exuded from the coal and renders the coal tough and more difficult to get. Sometimes the coal is crushed thus making large percentage of small, and the roof may be soft and crumbly. It not unfrequently happens that a dampness appears, although the old workings may not contain a dangerous accumulation of water.

Q. 14.—When a pump loses its water, what do you look for and how do you remedy the defect. What is the maximum height that a pump can be fixed above the level of the water to be pumped? (6 marks.)

A.—I should look at the clacks or valves, and if these were in a good working condition, I would expect to find an obstruction to the entry of water at the end of the suction pipe. The chief cause of defective working in pumps is the valves becoming worn, and being prevented from closing properly by

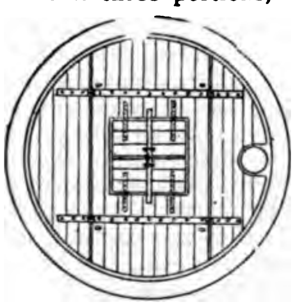
dirt. I should take out the clack door and clean out the dirt, if any, or renew the ring of the clack if necessary. The maximum height that a pump can be fixed above the level of the water to be pumped is about 26 feet for an atmosphere or suction pump, but there is theoretically no limit to the height for a lifting or forcing pump.

Q. 15.—How would you proceed to draw the timber in an abandoned working. What precautions would you take? (6 marks.)

A.—I would first examine the place carefully, noting particulary the roof, the position of timber to be drawn, and whether there was any likelihood of gas being liberated when the roof fell after a number of the props had been drawn out. The precautions I would take would be to have a man to assist me, and to be provided with the necessary tackle for withdrawing timber, viz.:—Pick, hammer, gablock, and chain. In taking out the timber I would commence at the far end, and begin to withdraw the timber in a regular order, taking care not to leave a number isolated away back in the waste, as this would increase the danger of taking them out, besides running the risk of losing the timber altogether. I would take particular care that the lamps were in a proper and safe condition, so that in the event of gas being liberated no serious damage could result.

Q. 16.—Give a sketch with dimensions of a bricking scaffold suitable and safe for a 13 feet shaft. (6 marks.)

A.—Sketch shows the ordinary form of scaffold suitable for a 13 feet shaft. It is made in three portions, and a clearance of



about 2 inches would be necessary, the diameter would therefore be 12 feet 8 inches. It is formed of 3 inch timbers firmly fastened to the iron straps which serve for hinges, and on the underside to other 3 x 9 inch cross-pieces. The side portions have four cross-pieces each, and the centre portion five. The main strap and hinge pieces are of ¾ inch by 2½ inch iron, and the hinges for the centre small doors slightly less. It is suspended by four or six chains which are attached to two ropes.

(Concluded.)

EXAMINATION QUESTIONS.

(Newcastle District, 1894.)

FOR FIRST-CLASS CERTIFICATES.

No. 2 PAPER.

Time allowed Five Hours.

(Continued from Last Issue.)

I.—SINKING.

1. Describe with sketches the ordinary method of sinking, and give the dimensions of materials suitable for a 13 feet pit.

2. Explain fully and illustrate with sketches the method of walling a sinking pit.

II.—SURFACE ARRANGEMENTS.

1. Make a sketch showing the surface arrangements you consider necessary for a colliery 100 fathoms in depth, and having an output of 700 tons per day.

2. Describe and illustrate with sketches and dimensions the best examples of boilers, winding, pumping, and hauling machinery suitable for a colliery as above.

III.—UNDERGROUND ARRANGEMENTS.

1. Draw a plan showing how you would lay out the workings of a colliery for 125 hewers in each shift.

2. Give number of men in each district.

3. State the quantity of air in each split and indicate its course by arrows.

4. Show the position of all stoppings, crossings, doors, and regulators.

5. Show main ways and landings.

NOTE.—One half of output to be from bords and pillars and one half from longwall workings.

IV.—GASES.

1. Name the principal gases met with in coal mines.

2. Describe the nature and properties of each, the circumstances under which they occur, and the effect they have upon animal life.

V.—VENTILATION.

1. How would you ventilate a sinking pit?

2. *See instructions on accompanying two plans and explain how you would ventilate the workings shown thereon.

***We are unable to publish plans.—ED.**

VI.—Furnace and Fan.

1. Describe and illustrate with sketches and dimensions a ventilating furnace and a ventilating fan, each suitable for a current of 100,000 cubic feet per minute.
2. Explain the respective merits of each for the ventilation of mines.

VII.—Haulage.

1. Describe with sketches any system of mechanical haulage with which you are familiar.
2. Describe the method of working it.
3. Explain fully the method of attaching and detaching tubs at the several landings and other places necessary.
4. Describe the method of working curves and junctions.

VIII.—Dams.

1. Describe and illustrate with sketches the various sorts of dams used to stop water in mines.
2. State for what pressures of water they are suitable and the precautions necessary in constructing them.

IX.—Surveying and Levelling.

1. Describe the method of surveying with an ordinary compass and with a theodolite, and state the conditions under which you would make theodolite and magnetic surveys respectively.

2. Plot the following bearings :—

No.	Bearing.			Links.
1	S	12	E	332
2	S	69	E	357
3	N	44	E	475
4	N	21	W	260
5	N	41	W	400
6	N	85	W	802

3. Describe the process of levelling with a spirit level, and in the following account fill up the columns for rise, fall, and reduced levels, and also work out the average inclinations in inches per yard :—

	Backsight. Feet.	Foresight. Feet.	Horizontal Distance. Links.
1	1·85	10·85	100
2	8·45	1·17	100
3	3·65	11·02	100
4	8·52	0·67	100
5	3·34	9·94	100
6	0·89	8·03	100
7	10·72	3·50	100
8	2·55	8·55	100
9	1·35	8·43	100

ANSWERS TO QUESTIONS.

No. 16 Set—In No. 13, Vol. III.

ELEMENTARY.

Question 1.—Describe the pillar and stall method of working coal in two modifications. Give sketches.

Answer.—This system has been extensively adopted in north of England collieries. It comprises two operations, one known as the whole workings, and the other as the broken workings. The whole working is carried on first, and consists of driving one set of excavations in the solid coal, called bords, and another set at right angles to these, called walls or headways. The bords are usually across the cleat of the coal, and are the places that produce the chief output. The headways which are driven in a line with the cleat, or "on the end," are chiefly driven for ventilating and conveying purposes. In this manner the whole estate is cut into rectangular blocks of about 30 yards square, called pillars. The broken working or removal of the pillars is performed by taking strips of about 6 yards in width from the pillar until the whole of it is removed. In this case the pillars are brought back from the boundary, the farthest being taken first, so that when they are removed the roof may be allowed to fall; however in some cases the broken work has to closely follow the whole work up. It is generally admitted that the following-up system of the broken is better than that of leaving the pillars untouched until the boundaries are reached. Pillars left standing for a long time undergo deterioration, become crushed, and the roof of the excavations breaks down, thus increasing the cost of removing the pillars. All this is obviated by following the whole up at a convenient distance. Other important advantages in connection with the following-up system are:—The mine is more easily ventilated, as the air has not so far to travel or so many airways to ventilate, thus the cost of maintaining airways is not so much. Of course every mine has its own peculiar local conditions; the best system suitable to these conditions is applied, and, in consequence, we see both the following-up system and that of waiting until the boundary is reached before starting to get the pillars. Another plan is to arrange for barriers or solid ribs of coal to be left at certain distances apart, in order to divide the workings of the mine into

a series of separate districts or panels. Although this arrangement possesses many advantages, it is not adopted so extensively as might be expected. At the commencement three levels are driven on either side of the pit, and when at a sufficient distance from the shaft bottom places are started upbrow—the first to be driven is that which is intended to be the centre of that district. Out of this roadways are driven at intervals, rising slightly on either side, in order that the corves may be drawn from the working places with greater facility, it being usual to fix a self-acting jig in the centre brow. The pillars are taken out in a similar way in this system as in the other, excect that the barrier pillars are taken out a little after the side pillars. The advantages claimed for this arrangement are as follows:—(1) Less risk of an explosion, as each district has a separate air current. Should an explosion occur in one district, the others would not in all probability be affected. (2) The danger of creep occurring is minimised by reason of the barrier pillars, and again should creep occur in one district it is less likely to spread in the others. (3) Each district can be treated as a separate mine, in fact the general safety of the mine is greatly increased.

JOSEPH WHEATCROFT.

Two very good sketches of the Pillar and Stall Method of Working are given in Nos. 16 and 22, Vol. I.

ADVANCED.

Question 2.—What gases are likely to be found in the air of coal and metal mines respectively?

Answer.—In Coal Mines there are four compound gases found, viz.:—carbon dioxide, light carburetted hydrogen, hydrogen sulphide, and carbonic oxide.

In Metalliferous Mines the following gases are found:—Hydride of ethyl, carbon dioxide, hydrogen sulphide, and carbon oxide.

Carbon Dioxide or Carbonic Acid Gas.—This gas is known in different districts as stythe, choke damp, and black damp. It is composed of one atom of carbon combined with two atoms of oxygen. Its symbol is CO_2 and specific gravity of this gas is 1·529. It is produced in mines by the breathing of men and horses, the combustion of lights, and the explosion of gunpowder, and it is sometimes given off from the strata.

Light Carburetted Hydrogen or Methyl Hydride is known in mines as firedamp or marsh gas. It consists of one atom of carbon combined with four atoms of hydrogen, and its symbol CH_4 and the specific gravity is ·559, or about half the weight of air. This gas is produced naturally in most coal mines. Firedamp in a pure state will neither burn nor explode, and it will not support the respiration of men and animals, or the combustion of lights; but when mixed with air in certain proportions it becomes a highly dangerous mixture. When 1 volume of CH_4 is mixed with $3\frac{1}{2}$ volumes of air it does not explode but burns quietly; when 1 volume is mixed with $5\frac{1}{2}$ volumes of air it causes a slight explosion; when 1 volume is mixed with 9·38 volumes of air it attains its highest explosive point; when mixed with 13 volumes of air it explodes slightly, and on a further addition of air it becomes absolutely diluted.

Hydrogen Sulphide or Sulphurreted Hydrogen.—This gas consists of 2 atoms of hydrogen combined with 1 atom of sulphur—symbol H_2S. It is not found to any great extent in coal mines but mostly in metal mines, and it is produced by the decomposition of iron pyrites or "brasses" in the presence of water. This gas is detected by its peculiar smell—resembling rotten eggs—and if inhaled for a short time produces sickness. Its specific gravity is 1·191.

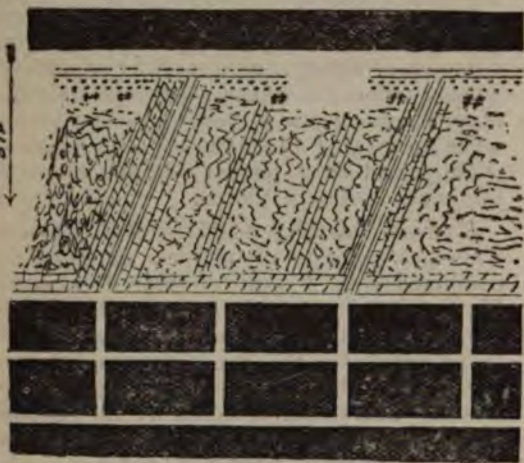
Carbonic Oxide or Carbon Monoxide is also known as white damp or sweat damp. It is composed of 1 atom of carbon combined with 1 atom of oxygen, and the symbol is CO. It is a gas which is always produced when incomplete combustion takes place, such as gob fires, explosions of gunpowder, and coal dust. Its specific gravity is ·967. This gas acts as a strong poison, and when air containing 1 % is breathed it quickly produces death. It will support the combustion of lights, an instance of which was proved at the Altoft explosion where several lamps continued to burn as long as the oil in the vessels lasted.

Hydride of Ethyl or Silver Gas.—This gas is composed of 2 atoms of carbon combined with 6 atoms of hydrogen, and the symbol is C_2H_6. This gas is found in marked quantities in most metalliferous mines, and produces a white silvery looking cap on the flame of a safety lamp, and from this it is known as silver gas. Its specific gravity is 1·044. There is another deadly gas which is common to both class of mines, viz.:—*Afterdamp.* This is the name given to the atmosphere of a mine after an explosion, and its composition varies according to the

mixture of air in the mine previous to the explosion, also the extent of the explosion and its nature whether of gas or coal dust.

Wm. P. Laws.

Question 3.—Describe in detail a method of longwall working suitable for a 4-feet coal with a dip of 1 in 6, showing the best method of securing the face. Give sketches.



Answer.—The method of working such a seam as the above may be plainly seen by observing sketch. It will be seen that the main winning places proceed along the strike of the seam or at right angles to the dip, and the gateways are 80 yards apart and advance to the rise, at an angle from the headways in a cross-cut direction. The gates are secured by 9 feet packs, which consist of the stone that is ripped from the roof or floor as occasion demands. The coals are let down to the main headings by a jigger on the principle of a self-acting incline. Between each gateway (see sketch) are built two safety packs, 9 feet wide, for the purpose of easing the goaf gently down, and not cause the coal to be too much crushed at the face. The coal is kirved to a depth of 3 feet, and is kept up by means of sprags and cockermegs set 6 feet apart.

Wm. P. Laws.

FIRST-CLASS.

Question 4.—With a winding shaft 500 yards deep with two cages working in it on weighted conductors. Describe a test by which you can ascertain (without an inspection of the weights in the dib-hole) that such weights are hanging free and clear, and are in working order.

Answer.—Supposing the weights to be resting on some support, which may be mud, having been deposited by the water in the sump. This will cause the rope to be slackened, owing to not being kept in tension by the weights, thus it will be noticed that there is more vibratory motion of the rope than hitherto afore. The slackness may be detected also by applying force to the rope causing it to vibrate, this will prove whether or not the ropes are taut. Also the sum of the weight of the ropes and the weights connected at the bottom may be taken. If the weights are in order it will necessitate the application of a power, which will be equal to raise the total weight, but should the weights be out of order, so that they are not free or clear, the difference will be easily noted as the weights which would be applied in the case under consideration would be 3 or 4 tons. The power could be applied by an arrangement of the lever and clams to grip the rope. But should this weight be taken off the guide rope, it would soon be apparent owing to the slackness of the rope—especially would this be the case in a furnace pit—for then it would take up the extra length due to expansion caused by heat.

Myles Brown.

Question 5.—In sinking a shaft how would you protect the bottom bricking ring from damage by shots when proceeding with sinking after bricking up? Give sketch.

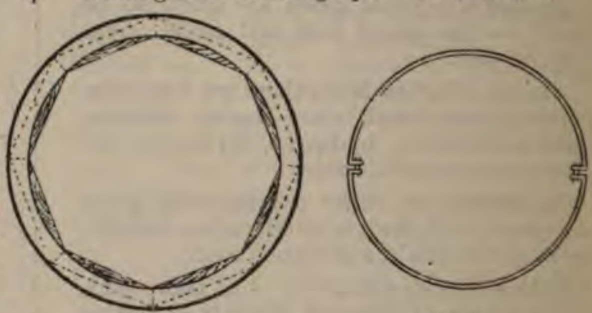


Fig. 1. Fig. 2.

Answer.—When a bricking ring or curb has been laid and the wall built up, it will be necessary to provide some arrangement for the protection of the ring or curb and the walling before the sinking can be proceeded with, that is in the cases when shot-firing is adopted. A simple and effective method is to construct an octagon of timber (fig. 1) and fix it in position under the last ring, so that any flying rock or stones will strike the timber and not injure the ring. A more perfect

method is to construct a drum (slightly less in diameter than the shaft) made of strong lengthy planks, which are kept in position by using iron hoops to which each respective plank is bolted, thus it forms an inner cylinder and receives all the blows from the shots, protecting both bricking ring and walling. The following are the actual sizes adopted at a sinking under the supervision of Mr. W. Wardle:—The wooden drum consisted of wooden planks 21 feet long, 9 inches broad, by 3 inches thick, and in each of these planks three holes were bored so as to allow ¾ inch bolts to pass through, the planks were fastened to three wrought-iron rings (fig. 2) made from 2½ inch by ⅛ inch iron; each ring was made in halves and connected together by four bolts (as per sketch); ¾ inch holes were punched in the rings at 12 inches apart, so that there was a clearance of 3 inches betwixt each plank, so as to allow space for the convenience of screwing the nuts on to the bolts. Thus the whole drum formed a casing or protection to the height of 21 feet. By adopting this method shots may be fired without any damage to the ring or walling. But of course due regard must be given to the bricking ring, and not allow any shots to be fired which are likely to damage it or wreck its foundation. But this of course will be left to the tact and judgment of the person in charge, who should however use every care when in the vicinity of the bricking ring. The adoption of wedges (if practicable) near the ring is to be recommended.

MYLES BROWN.

AWARDS.

FOR ANSWERS TO COMPETITION QUESTIONS—No. 16.

ELEMENTARY—J. Wheatcroft, 8, Longsight Terrace, Kinsley Hemsworth, near Wakefield.

Commended—T. Webster, T. A. Brown, W. Curtis, W. Roberts, J. Finch.

ADVANCED—W. P. Laws, 28, Pilgrim Street, Murton Colliery, Sunderland.

Commended—J. Moore, H. Hall, T. Williams, J. Stephenson, A. Halburstan, J. Crone, T. A. Aitchison.

FIRST-CLASS—M. Brown, Butterknowle, Darlington.

Commended—G. Daykin, T. Banks, S. Thorpe, J. Davis, W. Slocombe, R. W. Dixon.

ANSWERS TO CORRESPONDENTS.

H. F. BULMAN, Esq., Newcastle-on-Tyne, Secretary British Society of Mining Students. Much obliged for copies of Society's Journal.

R. H.—For description of the Flouss Respirator see No. 2, Vol II.

CANDIDATE.—Yes we have seen the paragraph to the effect "that a deputation of the Colliery Managers' Association waited upon the Home Secretary to suggest various amendments to the C.M.R.A., amongst which the want of uniformity in the examinations was included;" if that is the one to which you refer. We can only hope that this will have the desired effect.

OVER HULTON.—Refer to No. 2, Vol. III., for particulars of patenting, and if you wish for more information or for our opinion of your invention write us.

CORRESPONDENCE.

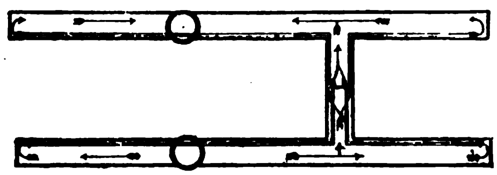
We will publish a reasonable amount of correspondence per issue, but subject to the following conditions:—

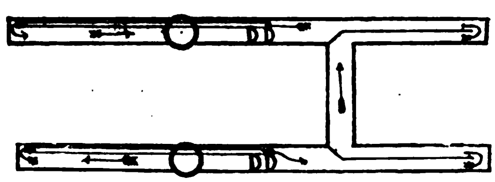
To be written on one side of the paper only.
Envelopes to be marked "Correspondence."
Name and address of sender must accompany such correspondence as a sign of good faith, but the writer may assume a *Nom-de-plume* to be published if he so desires.
Correspondence must not be enclosed with Competition Answers.

The Editor will not hold himself responsible for any correspondence, nor will the publishing of it affirm that we hold the same views as the writer.

PRACTICAL VENTILATION.

In No. 13, Vol. III., H. O. gave the following query. The sketch shows two levels opening out a seam of coal which is giving off much gas. How should the levels be ventilated by means of air pipes so that each place shall have fresh air?





The first of the above sketches showing a mode of ventilating the levels has been sent by "Miner," and fulfils the requirements of the question, but the second sketch sent by J. Tither, Pemberton, seems to be the most practical method, though each place does not receive fresh air as was required in the question.—ED.

Size of Engine required.

Sir,—Herewith I send you an answer to J. P.

For winding purposes a pair of horizontal direct-acting engines are most suitable, and one engine should be sufficiently powerful to start the load when the other is on the dead centre. Moreover, before calculating the size of the engine, the possibility of an increased output at some future date should be taken into consideration. It has been found in practice that a cage speed of 1,000 feet per minute is not excessive. That a piston speed of 400 cubic feet per minute is a fair average speed for an engine working intermittently, and that the length of the stroke of an engine should be about twice the length of the diameter of the piston.

Reasoning thus, let us proceed to answer the question—400 tons of mineral in 10 hours = 40 tons per hour, or ⅔ of a ton per minute, and as each cage carries 48 cwt., nearly 17 trips per hour must be made, or one trip every 3⅗ minutes inclusive of time taken to change tubs on both decks, lowering and raising workmen, and numerous small stoppages incidental to the working of a colliery. Suppose, therefore, that only one-half or 1⅘ minutes to be taken up for the actual time of one wind, we have $\frac{600 \times 3}{1000} = 1{\cdot}8$ average time for one wind.

Weight of a steel cage	= about 1 ton	10 cwt.	
„ mineral = 12 × 4	= 2 „	8 „	
„ four tubs = 6 × 4	= 1 „	4 „	
	5 „	2 „	+ the weight of the rope.

The weight of 600 yards of plough steel rope at, say roughly, 7lbs. per yard = about 1 ton 18 cwt., making a total of 7 tons as a safe working load of rope.

According to Andre, the square root of the safe working load in tons × 2·4 = the circumference of a steel rope. ∴ $\sqrt{7} \times 2{\cdot}4 = 4$ inches nearly, and by the same authority, a rope 1 inch in circumference requires a drum 10 feet in diameter, and the latter must be increased 6 inches for every ¼ of an inch in circumference of the rope. Thus a 4 inch rope will require a drum 16 feet in diameter, or 16 × 3·1416 = 50·26 feet in circumference.

As the cages and tubs balance each other they need not be considered, but we have at the end of a lever 50·26 feet long the weight of mineral and rope, or 4 tons 6 cwt. = 9632lbs. Now the power to overcome this is the pressure of the steam on the piston, and its leverage is the double stroke of the piston. Assuming, therefore, a 6 feet stroke for the piston and taking the pressure of steam on the piston as ⅘ths of the boiler pressure, or 60lbs. we have 6 × 2 × 60 × area of the piston = circumference of the drum × the load in lbs.

Therefore $\frac{50{\cdot}26 \times 9632}{6 \times 2 \times 60}$ = area of cylinder = $\frac{484{,}104{\cdot}32}{720} = 672{\cdot}36$, to which we had ½ for friction $= 672{\cdot}36 + \tfrac{1}{2} = 1008{\cdot}54$.

∴ $\sqrt{\frac{1008{\cdot}54}{{\cdot}7854}} = 36$ inches nearly, the diameter of the cylinders.

S. Thorpe.

The following is another answer to J.P.

Size of Engine required.

Question:—It is required to draw 400 tons of mineral, from a depth of 600 yards, in 10 hours, cages holding 4 tubs each, tubs weighing about 6 cwt. each, and carrying about 12 cwts. of mineral. Required, the size of engine cylinders, size of drum, and length of stroke of engines; steam pressure, 75-lbs. (This question was tried by Jno. Gray.)

400 tons drawn in 10 hours, $\frac{400}{10} = 40$ in one hour.

2·4 tons on cage, which will be 16·6 winds per hour.

40 tons divided by 2·4 tons, $\frac{40}{2{\cdot}4} = 16{\cdot}6$. This 16·6 winds made in one hour will allow 3·6 minutes to make a wind and change too.

Mineral raised on cage ...	2·4 tons
	1·2 „
Empty	1·2 „
Total	4·8 tons to be lifted.

Factor of Safety = 10 × 4·8 = 48·0

Breaking strain 48

Working load = $\frac{48}{10} = 5$ tons. $\frac{48}{2{\cdot}5} = 19{\cdot}2$

Weight of rope = C × ·9 × 19·2 = 17·28 lbs. per fathom. Circumference $\sqrt{19{\cdot}2} = 4{\cdot}3$

When there are two cages, the ascending cage and tubs balances the descending cage and tubs. Therefore the gross weight the engine will have to lift will be the mineral and the weight of rope, which in this case will be considerable. Weight of rope = 17·28 × 300 = 5184 lbs.

In this case the H.P. would be:—

$\frac{40 \times 2240 \times 1800}{60 \times 33000} = 81{\cdot}3$ H.P. to raise 40 tons in an hour.

Then the weight of mineral + weight of rope = 4·8 × 2240 = 5376 + 5184 = 10559.

The amount in lbs. is therefore 10559.

Then 3·6 minutes for making one wind and changing also. Suppose 3 minutes for making the wind, and ·6 to suffice for changing; and say 15 revolutions per minute: 3 minutes, and 15 revolutions per minute, multiplied, gives the number of revolutions to complete the journey of 1800 feet. To obtain the diameter of the drum. divide 1800 feet by 3 × 15 = $\frac{1800}{45} = 40$

Circumference of drum, 40 feet; divide 40 feet by $3{\cdot}1416 = \frac{40{\cdot}0000}{3{\cdot}1416} = 12{\cdot}7$

Diameter of drum, 12·7 feet.

Then the weight of mineral and rope will be 10559 lbs. (10559 × 1800) 10559 × 40 = $\frac{422360}{7854 \times 75 \times \frac{4}{5}} = 8800$

Length of stroke, 4 feet.

$\frac{8800}{8} = \frac{1100}{2} = \sqrt{5{\cdot}56} = 24$ inches diameter.

Two cylinders nearly 24 inches in diameter I consider this answer.

T. M'Creanor.

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CONTENTS.

EASY LESSONS ON
MINE VENTILATION.

By J. CARTER, First-Class Certificated Manager.

(Commenced in No. 9, Vol. III.)

SPLITTING OF AIR-CURRENTS IN MINES, ITS OBJECT AND THE ADVANTAGES GAINED THEREBY.

WHEN we speak of splitting the air-currents in mines, we mean dividing it into two, three, or more parts as the case may be, each part to form a separate and independent district of its own, as regards each having its own supply of fresh air. It is generally the case in mines, however, that the air has to be carried a distance along the main intake before it is split, and the split joins at a junction in the main return airway before reaching the upcast shaft, rendering the splitting of air-currents less effectual than it would be had splits been made at the downcast shaft, and kept in a separate course until the upcast shaft was reached. The greater the distance the air is taken away from the downcast before splitting, and the greater the distance of the junctions of the return splits from the upcast, the splitting of air becomes less and less effectual, so that when carried too far into the workings before splitting, we obtain comparatively small results as will be shown later on. In former times when mining was in its infancy, and mining officials had not acquired the same knowledge of the laws of ventilation that we have at the present time, it was the custom to send the whole of the air circulating in the mine in one undivided current through the whole of the workings in the mines, the consequence was as mines became extended and mines had to be sunk deeper our mine ventilation became inadequate, the result of this was that by degrees the splitting of air-currents was introduced on a small scale until it developed into our present system of extensive splitting.

The objects of this splitting of air-currents were—(1) To reduce the resistances offered to the air in passing through the mine by dividing the air into parts. (2) To obtain a better ventilation with same power used. (3) To reduce the number of doors and cloths in the main roads. The advantages gained by this system of ventilation were great. (1) More ventilation. (2) Safer and healthier for the men employed. (3) Less risk in case one portion of the mine became dangerous, because having divided it into districts danger became confined to its own district.

Splits may be of equal or unequal length and area. The expression "equal splits" is often found in questions relating to ventilation, when used it means the original one current is divided into two or more equal patrs as the case may be. If divided in two parts then each must be half the length of the other, if in three parts each must be one-third and so on, but each split must be of the same area as the original one.

When the expression "equal split" is used as applied to mine ventilation, it is more mathematical than practical, because it may be taken for granted that in mines owing to varying circumstances (some of which have been previously mentioned) the conditions are such that the practical splitting of the air-currents into two or more equal parts is never obtained, although in some cases it may approach very nearly to it.

Theoretical splitting will always show a better result than practical, owing to the various circumstances in the mine and airways of the mine through which the air has to pass.

The following must be borne in mind with regard to splitting the air-currents in mines. We do not enlarge the area of the shafts, consequently the increased resistance arising from the increased velocity of the air in shafts, sets a limit to the benefits resulting from splitting the air. Therefore the capacity of the shafts and the power that may be employed must be taken into account, as the number of splits will greatly depend on this. Owing to this resistance it is not practical to have more than a limited number of splits in a mine, although every additional split would increase the quantity of air passing in a mine, yet the velocity in each split would become less and less as each split was made, and if carried too far the velocity would become too feeble for its work, and instead of being a benefit it would become a source of danger, because the velocity would become too weak for its work of carrying off the noxious gases given off in the mine, thereby rendering the mine not safe to work in.

In laying out the ventilation of a coal mine care should be taken to arrange the splits as nearly as possible of the same length and area, so that an equal quantity of air will go into each district. When this is not the case regulators have to be used, and as these are an unnecessary drag on the mine they are objectionable, and where possible should be avoided.

In coursing the air round the workings of a mine, air-crossings are necessary when the return and intake air have to pass over or under each other. Doors should be as few as possible in main roads, and when used should fit properly and fall with the air. Stoppings when erected should be built of brick, and when put in cross places to the rise, should be at the bottom end.

The following calculations on splitting the air are based on the assumption that the splits take place at the bottom of the downcast shaft and reunite at the bottom of the upcast. In fact we assume the splits are equal. It may be necessary here to explain that when the original air-current is divided into two equal splits, we may consider them as one current with double the area, but with the same rubbing surface.

To show this more clearly take an airway 60 feet square and 150000 square feet of rubbing surface as the original airway of a mine. To split this into two equal parts we should have two airways, each would be 60 feet area, thereby making a total area of 120 feet, whilst the rubbing would be 75000 in each, making a total of 150000 as before. Should we split it in three or four equal parts then we should have three or four times the area, whilst the rubbing surface of the splits remained the same as in the original airway.

It will be seen clearer by putting it in the following form:—

(1) Original airway.	A = 60	S = 150000
(2) Two equal splits	A = 60	S = 75000
	A = 60	S = 75000
Equal to one current	120	150000
(3) Three equal splits	A = 60	S = 50000
	A = 60	S = 50000
	A = 60	S = 50000
Equal to one current	180	150000

Friction due to the shafts in our calculations must be taken into account or the results will be wrong, because the benefit derived from splitting the air in mines depends a good deal on the relative rubbing surfaces and areas of the shafts in comparison with those of the mine. However for the sake of younger students we will consider the effect of splitting without taking into account the shaft resistances, as it will enable them to gradually make themselves acquainted with the mode of calculation, and afterwards to see and compare the difference of the two results.

The following example is given for the student to work out for himself. Suppose we have 15000 cubic feet of air passing through a mine in one current. Area of the airway is 25 feet, and the rubbing surface 30,000 square feet. What quantity will pass through the mine when it is divided into two, three, four, and up to ten equal parts?

To find the quantity (q) the following rule will apply, $q = \sqrt{\frac{p\,A}{K\,S}} \times A$. Remember p = pressure, A = area, K = Co-efficient of friction, S = rubbing surface. In looking over this rule we shall find three factors which remain constant throughout, and those are p, K and S; therefore we cancel them, and then the rule will be reduced to the simple formulæ $\sqrt{A} \times A$. That is the relative quantities will be according to the square root of the area multiplied by the area.

The quantities that will pass through the splits are as follows:—

$q = \sqrt{1} \times 1 : 15000 :: \sqrt{2} \times 2 =$ 42462 cu ft. 2 splits
$q = \sqrt{1} \times 1 : 15000 :: \sqrt{3} \times 3 =$ 77942 „ 3 „
$q = \sqrt{1} \times 1 : 15000 :: \sqrt{4} \times 4 =$ 120000 „ 4 „
$q = \sqrt{1} \times 1 : 15000 :: \sqrt{5} \times 5 =$ 167705 „ 5 „
$q = \sqrt{1} \times 1 : 15000 :: \sqrt{6} \times 6 =$ 220455 „ 6 „
$q = \sqrt{1} \times 1 : 15000 :: \sqrt{7} \times 7 =$ 277807 „ 7 „
$q = \sqrt{1} \times 1 : 15000 :: \sqrt{8} \times 8 =$ 330411 „ 8 „
$q = \sqrt{1} \times 1 : 15000 :: \sqrt{9} \times 9 =$ 405000 „ 9 „
$q = \sqrt{1} \times 1 : 15000 :: \sqrt{10} \times 10 =$ 474342 „ 10 „
$p = 9{\cdot}37$ in each case.

To find the pressure apply the rule $p = \frac{K\,S\,V^2}{A}$ and by taking the original air-current we find the pressure required to be 9·37 lbs. per square foot.

$$p = \frac{K\,S\,V^2}{A} = \frac{{\cdot}217 \times 30000 \times {\cdot}36}{25} = 9{\cdot}37 \text{ lbs.}$$

Students will do well to work the above out in full and find the pressure for each, and for the sake of further exercise take the actual areas and find results; that is—

$\sqrt{25} \times 25 : 15000 :: \sqrt{50} \times 50 =$ the quantity that would pass through two splits.

$\sqrt{25} \times 25 : 15000 :: \sqrt{75} \times 75 =$ the quantity that would pass through three splits, and so on to the tenth example.

Now had the power remained the same instead of the pressure, we should have had the following result if the original airway passed 15000 cubic feet per minute, the quantity will be in direct proportion to the areas:—(1) 15000, (2) 30000, (3) 45000, and so on up to (10) 150000.

When the power (U) is given the quantity may be found thus $q = \sqrt[3]{\frac{U}{K\,S}} = A$, but as the factors K, S and A are the same in all the splits. They may be cancelled so that the quantities will be in direct proportion to the area.

It would be well to remind students that there is a great difference between splitting the air and adding an additional airway of the same length and area as the original one.

Let us take an example. An airway whose area (A) is 40 and rubbing surface (S) 20000, was passing 20000 cubic feet of air per minute. What quantity would be obtained if we added another airway of the same length and area as the original one? The added airway would cause the factor A and S to be doubled, therefore we can find the velocity thus $V = \sqrt[3]{\frac{U}{K\,S}}$

$$\text{Power (U)} = \frac{K\,S\,V^2}{A}$$

$$\text{Power} = \frac{{\cdot}0217 \times 20000 \times {\cdot}25 \times 20000}{40} = 54250$$

units of work.

$$Q = \sqrt[3]{\frac{U}{K\,S}} \therefore Q = \sqrt[3]{\frac{54250}{{\cdot}0000000217 + 40000}}$$

$\times 80 = 31748$ cubic feet per minute.

Again the quantity is according to the reciprocal of the cube root of the rubbing surface multiplied by the area. As S and A are in the proportion of one to two we may express it thus—

$$\sqrt[3]{\frac{1}{1}} \times 1 : 20000 :: \sqrt[3]{\frac{1}{1}} \times 2 = 31748$$

cubic feet per minute.

The last formulæ may perplex some of our younger students, therefore I will make it more clear for them, thus—

$\sqrt[3]{\frac{1}{1}} \times 1 = 1$ and $\sqrt[3]{\frac{1}{2}} \times 2 = \sqrt[3]{{\cdot}5} \times 2 =$ $\cdot 7937 \times 2 = 1{\cdot}5784$, so that it resolves itself into the following, and may be expressed thus—$1 : 20000 :: 1{\cdot}5784 = 31748$ cubic feet per minute.

(To be continued.)

THE ENGINEERING OF COLLIERIES

Being a Treatise on Colliery Machinery, Appliances, and Constructions.

By T. A. O'DONAHUE.

(Commenced in No. 9, Vol. III.)

WINDING.—CONTINUED.

ENGINES.—To the modern colliery manager there is no question of the horizontal engine being the most suitable for winding purposes, as the fallacies which attended the advent of vertical engines some years ago are now dispelled. The most common type of engine at present in use is shown in skeleton by fig. 21. It consists of a pair of

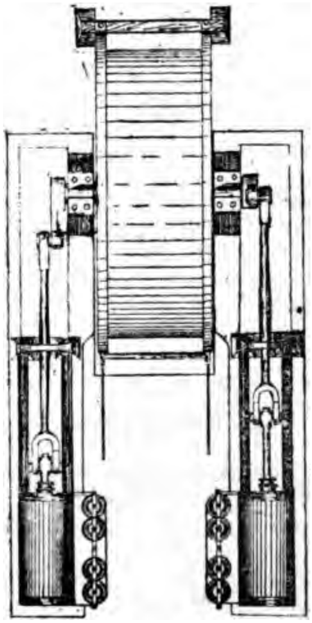


Fig. 21.

engines coupled direct on to the main driving shaft, one on each side, with the cranks at right angles to each other. The engines are non-expansive and non-condensing, and the valves shown in the figure are the Cornish or double-beat valve. There is a brake ring on each side of the winding drum, and the brakes pass half round the circumference. The brake levers (shown in the figure) are worked by the engine-man for ordinary circumstances, but should the power which he can apply be insufficient, the movement of a lever causes a steam piston to operate upon them.

As stated above the common type of winding engine is non-expansive and non-condensing, this means that the full pressure of steam is maintained throughout the whole of the stroke, and that at the end of the stroke a cylinder full of steam, in which there is a large amount of work, is discharged into the atmosphere. There is thus a loss in two ways, first, by using unnecessary steam, and second, by discharging steam from which more power could be derived. Now in a condensing engine working expansively the steam is admitted to the cylinder for a portion of the stroke only, and the remainder of the stroke is performed by the expansive power of the steam. At the end of the stroke instead of discharging the steam into the atmosphere it is condensed, and a partial vacuum is formed on the exhaust side of the piston. By producing a number of pounds vacuum on the exhaust side of the piston there is the same increase in power as would be derived from applying the same number of lbs. in the form of pressure on the other side of the piston. For example, if a non-condensing engine is using steam at a pressure of 60lbs. above the atmospheric pressure, that is at an absolute pressure of 75lbs., there may be a back pressure of steam equal to about 10lbs. in addition to the 15lbs. pressure of the atmosphere, and the effective pressure would only be 50lbs. Now take an example of a condensing engine working at the same pressure of steam. By condensing the steam on the exhaust side of the piston and producing a vacuum of, say 10lbs., the absolute back pressure is reduced to 5lbs. and the effective pressure of steam is 70lbs., as compared with 50lbs. in the previous case. It is thus clear that great economical advantages may be derived by working steam expansively and condensing the steam afterwards, yet it is only recently that these properties have been taken advantage of in winding engines, by reason of the great difficulties attending their application. The first considerations in the choosing of a winding engine are power, speed, and simplicity and efficiency in starting and stopping, and all other considerations, whether economical or otherwise, must be sacrificed to these. A winding engine, even when working a comparatively deep shaft, will not be running continuously for much more than a minute, and during this brief interval it must start from rest, get up a speed of perhaps 600 piston feet per minute and again come to rest; truly a remarkable performance under any condition, and one to which it would

seem impracticable to apply any appliance to effect this economy. With haulage or fan engines the full benefits of expansion and condensation may be derived, because these engines running continuously for considerable lengths of time offer every facility for so working. Not so, however, with the intermittent working of the winding engine, yet the large amount of power wasted in the non-expansive engine has induced engineers to attempt the expansive working of the engine in a modified manner, and with very satisfactory results.

To work expansively while the engine is starting from rest, is of course out of the question, as the engine requires all available power to start the load and get up the required speed. What is done, therefore, is to allow the engine to work in the ordinary manner for several revolutions, perhaps four, by this time there is a partial counterbalance of the load, the engine has attained a fair speed, and the full power is therefore not required, the expansion gear then comes into action, and the engine works expansively until the velocity is again reduced. There are several different contrivances for effecting the expansion, perhaps one of the best being Musgrave's or Steven's. It is automatic, effective in working, and requires no attention from the engineman. It is worked by the ordinary governor and may be arranged to come into action when the engine is at any required velocity.

Fig. 22 illustrates the action of the Musgrave appliance. A is the Cornish valve spindle, and B the ordinary lifting bar worked by the eccentrics. E F is a bent lever with its fulcrum H on the valve spindle. K is a spring, and C an eccentric, which may be made to turn a portion of a revolution by the lever D, which is worked by the governor. The action of the appliance is as follows:—The lifting bar B acting on the end F of the bent lever lifts the valve spindle and continues to do so during the whole stroke, if the lever is not displaced. During the first few revolutions of the engine the eccentric C does not interfere with the travel up and down of the lever E F, but as the velocity increases the eccentric is turned down, and instead of allowing lever E F to rise to the full height it comes in contact with the end E and depresses it, thus causing the other end F to leave the lifting bar, and the valve drops, while the lifting bar runs up to its full height, as if it was still raising the valve. On the downward journey immediately the lifter falls below the lever E F the end F is pressed into its position over the lifting bar by means of the spring K, and everything is ready for the next stroke. It will be seen that the greater the velocity the lower will be the eccentric, and the

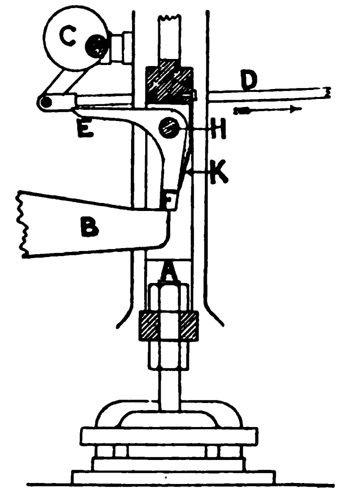


Fig. 22.

sooner will the trip gear come into action and cut off the supply of steam. In order to prevent a shock when the valve is suddenly liberated from the lifting bar, the upper portion of the valve spindle works in a dash pot, which allows the valve to drop gradually.

To work steam expansively to the best advantage the engines should be compound, that is—instead of having one cylinder to each engine there are two, a high pressure or smaller cylinder, and a low pressure or larger cylinder. The high pressure steam passes to the smaller cylinder, expansion takes place, and on the completion of the stroke the steam is discharged into the low pressure cylinder where it is again expanded. By this means the full benefit of the steam may be derived by having a larger number of expansions, such as would be impracticable in one cylinder. When steam expands and does work a large amount of heat is lost, and with a large number of expansions and with high pressure steam, the difference between the initial and final temperatures is such as to interfere with the proper working if performed in one cylinder. In a single engine after the completion of each stroke the final temperature is so low that a large amount of heat is expended in raising the temperature of the cylinder to that of the steam. By performing the expansions in two easy stages however, great

differences in temperature in any one cylinder is avoided. The compound engines which have been employed for winding purposes have been of the twin type; the engine consisting of two cylinders only as an ordinary pair of winding engines, but the steam first passes to the smaller cylinder, expands, then passes to the larger cylinders and again expands. The cylinders are placed one on each side of the winding drum, and the cranks are fixed at right angles to each other. With such an arrangement it sometimes happens however that there is a difficulty in starting the engine. If the crank of the high pressure cylinder chanced to stop on dead centre, the low pressure cylinder could give no help to raise the load having no steam, and it was found necessary to introduce a "bye-pass" valve to allow a portion of the high pressure steam into the low pressure cylinder at the commencement of the wind. This steam must be reduced in pressure to that ordinarily employed in the low pressure cylinder, either by a reducing valve or by throttling or wire drawing the steam.

At a South Wales Colliery, in a compound winding engine of this type, the "bye pass" valve has been discarded, or at least is not used for ordinary circumstances. This is achieved by having the high pressure cylinder large enough to do the whole of the work, and the crank of this cylinder is so fixed that it is at full turning point, when the load has to be started. A simple solution of the difficulty would be to employ a pair o compound engines with four cylinders, but as this would increase the cost of the engine, as well as make it more complicated, it does not seem to be greatly favoured, though a few are in use.

Condensation has not yet become generally adopted, though several collieries have within recent years fitted up condensers for winding and other engines. The best practice seems to be to have an independent condenser worked by a subsidary engine to condense the steam of all the engines employed about the surface of the colliery. Such a one is at present working at a colliery in this district (Wigan), and is employed to condense the exhaust of a pair of winding engines, two pairs of haulage engines, and a fan engine, and maintains a vacuum of about 10 lbs.

There appears to be no doubt that the engine of the future, whether for continuous or intermittent running, will be expansive working, compound and condensing.

(*To be continued.*)

EXAMINATION RESULTS.

East Scotland District.

List of Successful Candidates. Examination held in Edinburgh, May, 1896.

FIRST-CLASS CERTIFICATE.

Andrew Anderson	Jas. McWhinnie
Robert Barnard	John S. March
Thomas Battey	John Mathie
Wm. Bertram	John Muir
Patrick Brennan	Jas. Murray
Daniel Burns	Jas. Raisbeck
Hugh Caldwell	John W. Renwick
Campbell W. Campbell	Wm. Riddell
John Evelyn Carr	Robt. Robertson
Jas. Cook	Jas. Scobbie
John Cowie	Alex. Simmons
Robt. Cunningham	David Smith
Henderson Gibson, Jr.	Andrew Steele
John Halliday	Robt. Stewart
John Hannah	Andrew Thomson
Alex. Hill	Alex. T. Walker
John Hodge	David Wilson (Airdrie)
James Hunter	John Wilson ,,
George Hutchison	John Wilson (Trabbock)
David Jack	Robt. Wormald

Henry Kennedy   Andrew Kyle   David McPhail

SECOND-CLASS CERTIFICATE.

Henry Allan	Geo. Miller
John Andrew	Wm. Mitchell
Wm. Barr	Arthur H. Mottram
Wm. Black	John E. O'Keefe
Thos. Borland	John Pollock
Donald Boyd	Thos. Ritchie
Joseph Brown	Jas. Roden
Robt. Brown	Daniel Russell
John S. Cairns	Peter Samuel
John Clark	Jas. Sharp
Jas. Coulter	Archd. Smith
Alfred Curry	Robt. Sneddon
Alex. Gibson	Wm. W. Somerville
Richard Gibson	Wm. B. Sparrow
Wm. Grossart	Hugh D. Steele
John Haggie	Robt. Steel
Alex. Halliday	John Swan
John Howitt	Robt. Taylor
John Hunter	Geo. Thomson
Samuel Jackson	Jas. Thompson
Jas. T. Kerr	John White
Alex. McCullock	McIntyre Wilson
Andrew McCullock	Wm. T. Wood
John McDonald	Jas. Macfarlane

West Lancashire & North Wales.

List of Successful Candidates. Examination held in Wigan, June, 1896.

FIRST-CLASS CERTIFICATES.

(13 Competitors.)

Erne Hewlett	Mark Ramsdale
Wm. A. Smethurst	John Worrall

SECOND-CLASS CERTIFICATES.

(47 Competitors.)

Albert E. Aubrey	James Ashton	John Catterall
Wm. Edwards	John Evans	Jas. Hardman
Wm. S. Hughes	Jas. Lawrenson	Rd. M. Morton
Henry Norcross	H. Ramsdale	Rd. Robinson
John Settle	Wm. J. Silcock	J. Unsworth

George White

RULES FOR SHOT FIRING.

The following Rules shall not interfere with the Regulations of the C.M.R.A., which must be strictly carried out:—

1.—No shots allowed to be charged or fired except by persons authorised in writing by the manager.

2.—No shot firing is allowed except in such places and at such times appointed by the manager.

3.—No shots in coal shall be charged or fired in the fast or where the holing is not 6 inches deeper than the drill hole, or where any breaks are found in connection with the drill hole likely to contain gas, or where the holing is less than — feet — inches deep.

4.—Should any explosive become fast in the drill hole before reaching the far end, the hole must be stemmed up and another hole drilled in the same direction as the first but not less than 12 inches from it.

5.—Before any shot is charged its direction must be marked out on the roof or other convenient place, so that in case of mis-fire the direction of the hole will be known and prevent the relieving hole being unknowingly drilled into the charge of the missed shot.

6.—All shots to be fired by the person who couples up, and in all cases he must have the battery with him when doing so; and care must be taken by him that the cable is not plucked and the connection between detonator wire and battery thereby disturbed.

7.—If a shot misses fire, the shot-firer may, after disconnecting the cable and battery and taking the battery with him, make an examination for the purpose of discovering the defect. If still unable to fire the shot he shall at once fence off the place, put up a danger board or signal, and shall as early as possible, inform the persons working in the place. Such danger signal and fence shall not be removed until after the lapse of one hour, and then only by an authorised person, who shall tie the detonator wire of the missed shot to a board or prop so that it may be recovered after firing the relieving hole.

8.—Shot firing shall commence in each district at the return end of the ventilation, and no shots are allowed to be fired in any main return or haulage roads without express permission from the manager.

9.—All shots must be fired singly, except in places otherwise allowed by the manager.

10.—No explosives to be used except those supplied by the colliery.

11.—No shots to be fired except by electricity.

12.—Shot-firers must ascertain the number of the charges and detonators befoie starting, and shall keep an account of the charges used and fired; also report the number, if any, missing to the under-manager.

13.—In no case shall detonators and explosives be carried together, but they must be put in separate locked cases. They must also be sent separately down the shaft, and not more than 5lbs. of explosive to be in any one case.

14.—All explosives and detonators must remain in their respective cases until they are required for use, and must not be placed on the floor.

15.—The shot-lighter must, after the firing of any shot, examine all places contiguous to the shot and satisfy himself that everything is safe before allowing the men to resume work.

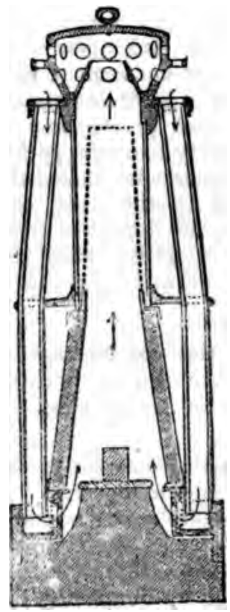
ANSWERS TO QUESTIONS.

No. 17 Set—In No. 14, Vol. III.

ELEMENTARY.

Question 1.—Describe the principle of the safety lamp, and describe two of the best forms. What method of locking or securing the lamp do you prefer?

Answer.—The principle of the safety lamp is in the power of a woven wire gauze to dissipate the temperature of the flame of the lamp to such an extent as to render it unable to ignite any explosive mixture of air or gas outside of itself, and this was the principle on which Sir Humphrey Davy made his Davy lamp. This principle refers to the safety lamps now in use; other safety lamps such as the electric lamp, completely isolate the heat from an outside atmosphere. The wire gauze has 28 wires in a lineal inch and 784 apertures to the square inch. Two of the best forms of safety lamps which I describe will be the Hepple-White Gray lamp for the purpose of testing gas, and the Marsaut for general work. 1. The Hepple-White Gray lamp. This lamp is generally preferable to all others for use by deputies and firemen. It is too heavy for general use, but is specially suitable for gas testing purposes. It gives a good amount of light, especially on the roof. It requires very careful handling, as the light is easily put out even when gas is not present. The distribution of light on the roof is due to the truncated-cone form of the glass. There is one great point in its favour, and that is the rapidity with which gas is detected. With it, it is scarcely possible to miss gas, even though it is present in small quantities when passing hurriedly from one place to another, which can not be done with any other form of lamp, unless great precaution is used, or the gas is present in larger quantities. The lamp can be fed with air from the top or bottom, or from both. The air enters the four tubes and passes



through a gauze before impinging on the flame. The top of the glass is surrounded by a conical gauze, which is surrounded by a shield. There are holes on the top of the lamp for the heated air to escape. When used for gas testing purposes the lower holes on the tubes are closed by the slides, and all the air entering the lamp passes through the four holes at the top, hence if only a thin stratum of gas exists near the roof, it would pass into the lamp and show itself, and for gas testing purposes is a very good lamp, but for general work I prefer the Marsaut or deflector. The principal difference in the two is the guiding of the inlet air, which in the deflector is admitted through a row of holes in the horizontal flange supporting the shield, and is prevented from impinging on the gauze by a vertical cylinder of brass 1½ inches high, which acts as a guide and directs the ingoing current of air vertically upwards. The cylinder is not placed close to the gauze, but occupies an intermediate position between that part and the shield. The inlet air, after being directed upwards, meets this deflector and is thrown into the flame of the lamp, and as the lamp gets hot more air rushes in and passes on to support combustion. This forms an explanation of why so good a light is obtained, the light at the end of the shift being nearly as good as it was at the beginning. The old method of locking lamps, which used to lock with keys underneath or at the bottom of lamp, was very inadequate, as a miner could get a key to fit his lamp and open it to relight it, or for some other convenient purpose which was an act of the greatest possible danger. I prefer the lead pivets now in general use for locking safety lamps, together with the initials of the person who locked the lamp thoroughly stamped on the rivet, as I do not know a case where the lamp has come unlocked after being thoroughly locked by this method. JOHN HENRY SENIOR.

Question 2.—What is the composition of common blasting powder, and what methods have been suggested for increasing its efficiency?

Answer.—Common blasting powder is one of the types of the first-class explosives. It is a mixture of the combustibles, carbon and sulphur, with potassic nitrate as the oxidising material. In blasting powder a slight lowering of temperature is obtained by increasing the proportions of sulphur present and reducing the oxidising material, the result being that during an explosion the products of combustion, although increased in volume, consists largely of imperfectly oxidised bodies, which are themselves inflammable, whilst in ordinary gunpowder the proportions are so arranged as to give great heat energy to the explosion.

COMPOSITION OF BLASTING POWDER.

	England.	France.	Italy.
Potassic Nitrate ...	65	62	70
Sulphur	20	20	18
Charcoal	15	18	12
	100	100	100

PRODUCTS OF COMBUSTION.

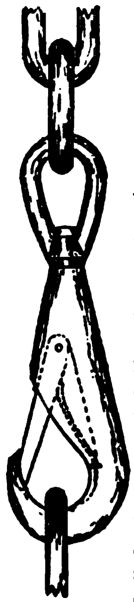
Carbon Dioxide	32·15
Carbon Monoxide	33·75
Nitrogen	19·03
Sulpuretted Hydrogen	7·10
Marsh Gas	2·75
Hydrogen	5·22
	100·00

The only word that can be said in favour of blasting powder is that it is cheap. It is I think absolutely unfitted for use in coal mines, and its abolition would no doubt reduce the number of deaths caused by mining explosives. The great danger attending its use, however, consists in the combustible nature of the products, evolved during decomposition, a factor in coal mine explosions which cannot be over-rated. It has been estimated that on firing a charge of 1½ lbs. of blasting powder, over three cubic feet of combustible gas, consisting chiefly of carbon monoxide would be produced, and this mixed with pure air would give over 10 cubic feet of an explosive mixture, or if not an explosive mixture, at any rate a rapidly burning one. Experiments have been made upon the effects of firedamp and carbon-monoxide combined in causing colliery explosions, which tend to show even when firedamp is present in such minute quantities as to be far from the explosive point, yet it would make the mixture of air and monoxide highly explosive. Many methods for increasing the efficiency of blasting powder and other explosives of the first-class type have been suggested, such as Trench's fire extinguishing compound, and experiments have from time to time been made with varying results, which I think will not to any great extent increase its efficiency.

JOHN HENRY SENIOR.

ADVANCED.

Question 3.—Accidents frequently occur through using imperfect hooks for supporting the kibble during sinking. Describe and sketch a good form of hook which will not shake loose, either during the wind or in case of an overwind.



Answer.—Many accidents have occurred, no doubt, from the very cause referred to in the question with most serious and disastrous effects simply by using what we might term an open *l* hook, which is liable even with a sudden jerk to loose itself from the hoppit, and also by inefficient management at the surface. The only means to minimise these accidents is to adopt some form of hook which cannot possibly come loose until the workmen themselves detach it. A very good method is not to detach the hook from the kibble at the surface at all, only on special occasions, this being done at the bottom and properly attended to by the chargeman. The accompanying sketch shows a simple and very effective hook which is sometimes used, consisting of an ordinary form of hook with a spring attachment. In large and deep sinkings the connection is very often made with a large D link and bolt. T. H. DIXON.

Question 4.—State what arrangements are desirable in connection with the winding arrangements of a deep mine to ensure safety when winding at a high speed.

Answer.—When winding at high speeds we must consider the engines, ropes, conductors or guides, pulleys, and brakes, and also other safety appliances. Dealing with the above in order, the winding engines should be of the direct-acting type, that is, working in pairs, and easy to handle, and also be capable of dealing with any load which they might be called upon to do. One engine alone ought to be equal to the load, and there should be two engines of that size. They also should have the visor, or some other arrangements in connection with the winding machinery, such as Janson's appliance for the prevention of overwinding, which acts upon the steam supply and the brake in the following manner:—A lever is adjusted in such a position above the place where the cage should be stopped, so that if the cage was pulled to far, or struck the lever, a lock would be released resulting in the steam supply being cut off from the engines and allowing it to pass into the brake cylinder, thereby applying the brake and immediately arresting the motion of the engine. Secondly, the ropes should be made of the very best improved plough steel, and each wire and strand should be properly tested before being made up and its breaking strain ascertained, and a large factor of safety should be allowed. Either Lang's patent lay, or Elliot's locked coiled ropes are most suitable for winding and gives good results. Guides of iron or steel wire ropes are the best, being suitably secured at the surface and weighted at the bottom, sufficient to provide rigidity or stiffness to prevent any oscillation. The pulleys should be made with cast-iron boss and rim, connected by wrought-iron spokes, the shaft should also be composed of wrought-iron, suitably turned in its working parts or bearings. The bearings should be as small and the pulley as large as possible, tending as much as possible to reduce friction. Ormerod's or Walker's patent detaching hook should be in connection with the winding rope, in case the other appliances should fail, which would, if required, come into active operation and detach the rope or liberate it, and at the same time suspend the cage.

T. H. DIXON.

FIRST-CLASS.

Question 5.—What do you consider to be the most effective method of dealing with the question of shot-firing in mines, having in view the prevention of accidents, and economical and practical working? Give a list of the rules which you would have drawn up for the guidance of the shot-lighters.

(No adequate answer received. For rules for shot-firing see page 207.—ED.)

Readers will please notice that we have made arrangements with Messrs. W. H. Smith and Son, to supply our Journal at all their bookstalls on order.

AWARDS

For Answers to Competition Questions—No. 17.

Elementary—John Henry Senior, 16, Thompson Row, High Street, Rawmarsh, Rotherham.

Commended—Thos. Rimmer, T. Webster, Joseph Wheatcroft, W. T. Hewitt.

Advanced—T. H. Dixon, West View, Featherstone.

Commended—J. Jones, H. Hall, J. Stephenson, W. Mitchell, T. E. Aitchison.

First-Class—No award.

Commended—M. Brown, J. Davies, S. Davies, G. Daykin, W. Slocombe, T. Lawrenson.

COMPETITION QUESTIONS.

We make an uniform award of 2s. 6d. to the sender of the best answer to each of the questions given. Answers to be as brief as possible, and sketches must be made when necessary. One or both questions may be answered.

Envelopes to be marked "Competition," and to reach us before July 26th, 1895.

We invite readers to forward questions for this competition.

(1) If you suddenly found you had a higher side goaf filled with firedamp, the goaf being 50 yards up and 100 yards wide, with a drawing road on each side, describe the course you would take to remove the gas, assuming you had sufficient air.

(2) Describe how you would drive and secure a staple pit, 10 feet diameter, upwards from one mine to a mine 20 yards above.

EDITORIAL NOTES.

The Gold Medal and other Competitions conclude with the answers to be published next issue, and we will endeavour to make the awards as early as possible. In order to give the general competitors a little respite we purpose discontinuing the present series of competition questions and giving only a few questions without any restriction to classes to be answered by our readers. An uniform prize of 2s. 6d. will be given for each question, and as we purpose introducing several new features into our journal we desire that the answers should be as brief as possible so that none of our limited space will be pithless.

* * *

Now that we are inclined for changes we would be pleased to receive suggestions as our correspondent, Mr. T. E. Aitchison, advises, though it would be too much to hope that all will have so flattering an opinion of our work as this correspondent. We think the largest portion of our readers are in what we may call the mediocral stage of their studies, if not in the advanced, and they would, no doubt, appreciate an effort on our part to raise the standard of the paper.

CORRESPONDENCE.

We will publish a reasonable amount of correspondence per issue, but subject to the following conditions:—

To be written on one side of the paper only.

Envelopes to be marked "Correspondence."

Name and address of sender must accompany such correspondence as a sign of good faith, but the writer may assume a *Nom-de-plume* to be published if he so desires.

Correspondence must not be enclosed with Competition Answers.

The Editor will not hold himself responsible for any correspondence, nor will the publishing of it affirm that he holds the same views as the writer.

Size of Engine Required.

Sir,—In response to your request, I beg to submit a solution to J. P.'s question which will be somewhat different to that given by Mr. Gray. I will base my calculations on the assumption that the load moves through $5\frac{1}{2}$ feet per foot travel of piston. Assuming the total load to be as follows:—

	Cwt.
Mineral	48
Empty Tubs	24
Cage	30
Rope	50
Total ...	152

Then we have what may be termed a case of equilibrio in the following:—

$$D^2 \times \cdot 7854 \times 75 \times 2 = 152 \times 112 \times 5\tfrac{1}{2}.$$

Where D is the diameter of each cylinder. But in order that the engines may overcome the load, we will allow $\frac{1}{4}$th of the total load for resistances; then we have $D^2 \times \cdot 7854 \times 75 \times 2 = 152 \times 112 \times 5\cdot 5 \times \frac{5}{4}$ths.

$$\therefore D = \sqrt{\frac{152 \times 112 \times 5\cdot 5 \times \frac{5}{4}\text{ths}}{75 \times \cdot 7854 \times 2}} = 30\cdot 88.$$

Say, 31 in each cylinder. Taking the stroke at 2·5 diameters long. $\frac{31 \times 2\cdot 5}{12} = 6\cdot 45$ feet—say 6 feet.

The pistons move through 12 feet per revolution of drum, but the load moves through $5\frac{1}{2}$ feet per foot of piston. $\therefore \frac{5\cdot 5 \times 12}{\frac{22}{7}} = 21$ feet diameter of drum.

J. C. K.

Size of Engine Required.

Sir,—I have pleasure in sending my solution of J.P.'s question.

Question.—How would you lift 400 tons of mineral say in an 8 hours' winding day from a depth of 300 fathoms, tubs 6cwt. each when empty, each carrying 12cwt. of mineral, steam pressure 75lbs. ?

ANSWER.—We will arrange the process in steps.

(1st.) $\frac{400 \times 20}{12\text{cwt.}} = 666·66$ tubs. $\frac{666·66}{8 \text{ hours}} = 83·33$ tubs per hour, but as no half tubs are drawn we will say 84 tubs per hour.

(2nd.) Speed of winding, say 4 fathoms per second.

$$\therefore \frac{300}{4} = 75 \text{ seconds to run.}$$

(3rd.)
75 seconds to run
20 ,, to change
—
95 ,, per wind

(4th.) $\frac{1 \text{ hour}}{60 \text{ secs.}} = \frac{60 \times 60}{95} = 38$ winds per hour.

Now, as we have 84 tubs per hour to wind, and we can only do 38 winds per hour, we shall require $\frac{84}{38} = 2·2$ tubs per wind.
Two tubs per wind are not sufficient, so we will say four tubs per wind, and this will allow a little time to spare.

(5th.) To find size of rope (plough steel):—Dead load on rope =

	Cwt.
Cage	40
Four Tubs	24
Mineral	48
Rope (say 20lbs. per fathom)	54
	166
Safe Load	10
20)	1660
Breaking strain ...	83 tons

(6th.) Test of rope (plough steel):—Cir.^{2} × 3 = breaking strain.
$\therefore$ Cir.^{2} = $\frac{\text{Breaking strain}}{3} = \frac{83}{3} = 28$ weight of rope = Cir.^{2} × ·9 = 28 × ·9 = 25·2 lbs. per fathom, so that the 20lb. rope assumed is too light, as it should have been 25·2 lbs., or 26 lbs. per fathom.

(7th.) Engines and drum. Let—

D = Diameter of cylinder in inches.
$2 \times D$ = Stroke in inches for quick speed.
$\frac{1}{12} \times 4 \times D$ = Two strokes in feet.
$\frac{1}{12} \times 6 \times D$ = Drum in feet.

(8th.) Work done in steam cylinder in one turn of drum = work done in shaft in one turn of drum. Area of cylinder × Pressure × 2 stroke × eff. = unballanced load × distance raised = mineral and rope × circumference of drum. $D^2 \times ·7854 \times 75 \times \frac{1}{12} \times 4 \times D \times ·8 = 13176 \times \frac{1}{12} \times 6 \times D \times 3·1416$.

$$D^2 = \sqrt{\frac{13176 \times 6}{75 \times ·8}} = \sqrt{\frac{79056}{60·0}} = \sqrt{1317·6} = 36''$$

$\therefore$ D = 36 inches. Stroke twice D = 6 feet. Drum six times D = 18 feet.

A single engine, 36 inches dia., would just lift load, so that a pair of 30 or 32 inches would give good speed. It is best to get engines made of a stock size to save the expense of new patterns.

SUMMARY OF ANSWER.—Pair of 36 inch coupled engines, 6ft. stroke, 18ft. drum, 75lbs. steam pressure.

I hope, sir, that I have not encroached too much on your valuable space in my answer to J.P.'s question, which I trust will be fully understood by him. I may also say that in my opinion "Mining" is the foremost journal of the present day. Every article in it is so plain that any one can follow and understand them. I should like very much to see it published at 2d. and enlarged accordingly. Would it not be possible to get the voice of your subscribers upon the matter ? I for one would be pleased to give 2d. or even 3d. for a copy of it. Of course you would be able to give us more printed matter. Wishing success to "Mining,"
I remain, yours, &c. THOS. E. AITCHISON.

[We think we have now published sufficient answers to this problem of size of engine required, with reference to latter part of this letter see Editorial Notes.—ED.]

ANSWER TO VENTILATION QUERY.

Sir,—I append answer to the following question given by "Deputy" in No. 15:—A return air-current of 10,000 cubic feet per minute is in the proportion of 1 of CH_4 to 13 of air, what is the least volume of air per minute which must be added to the current to prevent its showing a cap ?

ANS.—With an ordinary safety lamp a cap will not show until there is about 2% of CH_4 present, or it is mixed with the air in proportion of 1 to 49. If the return air-current contained 1 of gas to 13 of air, one-fourteenth of the total quantity passing will be gas, or $\frac{10000}{14} = 714\frac{2}{7}$ cubic feet per minute of gas. To prevent this gas showing a cap will require 49 times this amount of air, which added to the volume of the gas itself will be $714\frac{2}{7} \times 50 = 35714\frac{2}{7}$ total volume of air-current. The original volume was 10000 $\therefore$ quantity of air added = $35714\frac{2}{7} - 10000 = 25714\frac{2}{7}$ cubic feet. R. P.

PRESSURE OF WATER IN PIPES.

Sir,—I would be obliged for an answer to the following through the medium of your journal:—I have three series of vertical water pipes, 9, 6, and 3 inches diameter, and 400, 300, and 200 feet long respectively. Assuming that the pipes are in connection with a tank at the surface, which is open to the atmosphere, and that each is provided with a 3 inch tap at the bottom which is fully opened, what will be the pressure at the bottom of each, and explain why ? If a gauge was inserted in the smaller pipe half-way down what would it read in lbs. ? What would be the flow from each pipe ? HYDRAULIC.

CURRENT NOTES.

Colliery Development in Northumberland.—The Cramlington Coal Company, Ld. have commenced operations for the sinking of a new shaft at East Cramlington, the purpose of which is to bring coal from the area at present worked from Shank House. This will effect a considerable saving in the cost of underground haulage, and workmen will also be enabled to reach the places more quickly. This idea has been carried out successfully at the neighbouring colliery of Seaton Delaval; but whereas the Delaval Co. instituted a system of surface haulage to take the coals to New Delaval screens, 1½ miles away, the Cramlington Co. purpose erecting screens of the "jigger" type at the shaft mouth.

* * *

Colliery Development in South Wales.—The Dowlais Company at their sinking at Aberdare Junction have recently found the Upper 4-feet seam of steam coal at a depth of 700 yards. The thickness of the coal is 7ft. 3in. and is of excellent quality.

* * *

Boring Operations at Teesdale.—For some weeks past boring operations have been in progress in Teesdale. The site is Holdsforth Farm, near Egglestone, and about 7 miles NE of Barnard Castle Station. The nearest coal which is being worked is at Wooley Hill, not far from Woodlands. The first hole was put down about 30 feet when a fault in the strata stopped operations; 6in. of coal through, then 18in. of coal and shale band, and a little further down a 6in. seam of excellent coal. A fresh spot has been chosen for further explorations.

* * *

Boring Operations in Warwickshire.—The North Warwickshire Coalfield is being steadily developed; boring operations have for some time been progressing on Mr. F. A. Newdegate's Astley estate, and after going down to a depth of several thousand feet the coal measures have at length been proved. This fact coupled with the recent discovery at Exhall will no doubt play an important part in the future of the coalfield.

* * *

Probable Extension of the South Staffordshire Coalfield.—An undertaking, which may prove to be of great importance to the district, has just been commenced, to develop the South Staffordshire coalfield at Penn, near Wolverhampton. The nearest coalpits are at Rough Hills, Wolverhampton, on the one side, and Himley on the other, and although it is generally admitted that there is coal underlying the Penn district, the probable reason that no one has attempted to reach it is that it is believed to lie in a basin, and that the shaft would have to be sunk to a great depth. Whether this theory is the correct one is about to be tested. A few months ago Mr. James Lakin, of Penn, opened a gravel pit at Minchall, a little place situate between Goldthorn Hill, Wolverhampton, and Penn Common, and discovered close to the surface a deep and most valuable bed of clay and marl, which is now being utilised in brick and tile making. The place has been visited by a number of people who are conversant with mining operations and the geological conformation of the South Staffordshire district, and in their opinion a bed of coal will be found beneath the marl. Acting on the advice given him, and having secured competent assistance, Mr. Lakin has commenced to sink a shaft close to his marl-hole, and a depth of 15 yards has been reached. The sinkers are still in the marl, and it is believed that by the time the shaft has been sunk to a depth of 50 yards, indications will be observable as to the likelihood of coal being reached at a reasonable depth. Should coal be discovered at Penn, further developments would doubtless follow in the locality, and the often-talked-of railway from Wolverhampton to Bridgnorth might be laid down.

* * *

The Drainage of the South Staffordshire Coalfield.—On June 22nd, the South Staffordshire Mines Drainage Commissioners concluded negotiations for the advance of a loan of £100,000 by the Public Works Loan Commissioners to carry out an important scheme for the drainage and development of the mines in the Tipton and Bilston district. The authority for this was obtained by a special Act of Parliament last year. A large mineral area containing the 10-yard thick coal and other valuable measures is at present submerged, and notwithstanding that large sums of money have been expended in pumping operations the mines could not be worked. By means of the loan just concluded it is proposed to carry out works and put down a powerful plant for draining the area in question.

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MINING

A JOURNAL DEVOTED TO THE INTERESTS OF MINING STUDENTS.

No 18. Vol. III. SATURDAY, JULY 27, 1895. FORTNIGHTLY ONE PENNY.

CONTENTS. PAGE

EASY LESSONS ON

MINE VENTILATION.

By J. CARTER, First-Class Certificated Manager.

(COMMENCED IN No. 9, VOL. III.)

SPLITTING OF AIR-CURRENTS.—Continued.

AS has been previously stated the area of shafts must be taken into account when the splitting of air-currents in mines are being made, as must also the areas of the roads along which the air passes before being split, and again from the uniting point to the upcast shaft, because in these parts of the mine we have a greater velocity, hence it requires a greater pressure, and consequently in the splitting of air-currents the increased amount of ventilation resulting therefrom is considerably diminished, because too much of the available power will be expended on these portions of the roadways owing to the excessive velocity which will have to be maintained. To point this out more clearly I will give an example with a sketch, and for this purpose I simply show the main roads. As all splits cannot be made at the bottom of the downcast shaft a greater portion of them are made after the air is taken some distance along the roadway of the mine before splitting, therefore the example given points out such a course of splitting. For example, say we have 64,800 cubic feet of air passing through a mine, the roadways are 9 feet by 6 feet throughout, the districts are divided into three equal parts from the point of the air-splitting to its uniting again in the return, so that in this case each district will pass 21,600 cubic feet of air per minute with the same pressure. In order to compare the power expended on the splits and those portions of the mine (1) when the whole amount of air is travelling in one volume (2) when two-thirds of the air is travelling in one volume, we must find the pressure producing ventilation in each case. (See fig. 1.)

Take the split C in the first case, and find pressure and power required to pass 21,600 cubic feet of air per minute through it. The length of the roadway is 460 yards:—

$$P = \frac{K\ S\ V^2}{A} =$$

$$\frac{\cdot 0217 \times 1380 \times 30 \times \cdot 16}{54} = \frac{143 \cdot 7408}{54} = 2 \cdot 6618 \text{lbs}$$

$2 \cdot 6618 \times 21600 = 57494 \cdot 88$ units of work.

The other splits, E and F, being equal, the pressure and power must be the same in each case, so that the student can work them out as above for himself, or we can take the three splits as one road and proceed thus:—

$$P = \frac{K\ S\ V^2}{A} =$$

$$\frac{\cdot 0217 \times 12 \times 200 \times \cdot 16}{162} = \frac{431 \cdot 2224}{162} = 2 \cdot 6618 \text{ lbs.}$$

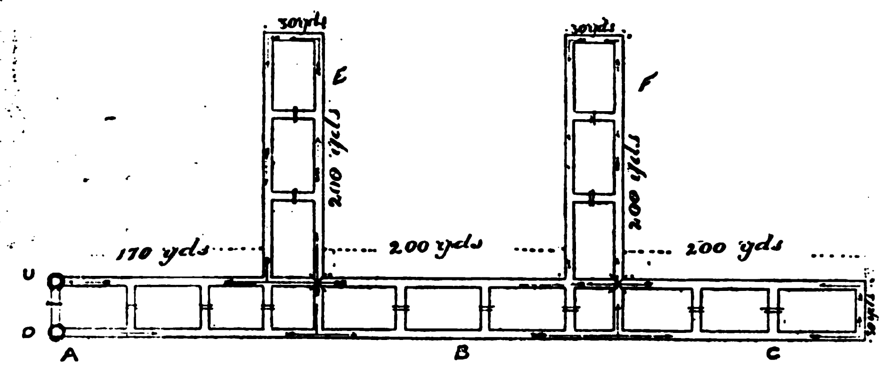


Fig. 1.

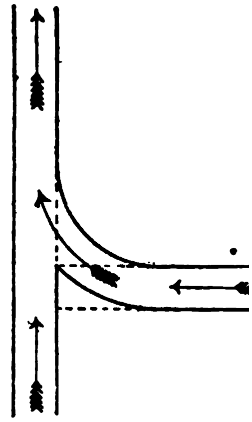


Fig. 2.

$2{\cdot}6618 \times 64800 = 172484{\cdot}64$ units of work for the three splits.

Let us now take the portion A, whose length is 370 yards. In this portion the whole volume, 64800, has to pass, so that we must find the pressure required to pass this amount:—

$$P = \frac{K\ S\ V^2}{A} =$$

$$\frac{{\cdot}0217 \times 33300 \times 1{\cdot}44}{54} = \frac{1040{\cdot}5584}{54} = 19{\cdot}2696 \text{ lbs.}$$

$19{\cdot}2696 \times 64800 = 1248670{\cdot}08$ units of work.

Take the portion B and find pressure and power to pass 43200 cubic feet of air, the amount passing through this portion, whose length is 400 yards:—

$$P = \frac{K\ S\ V^2}{A} =$$

$$\frac{{\cdot}0217 \times 36000 \times {\cdot}64}{54} = \frac{499{\cdot}968}{54} = 9{\cdot}2586 \text{ lbs.}$$

$9{\cdot}2586 \times 43200 = 399971{\cdot}52$ units of work.

Observe here the pressure and power required in each case:—

	Pressure.	Units of Work.
(1) Portion A, the whole volume of air	19·2696	1248670·08
(2) Portion B, two-thirds of ditto..............	9.2586	399971·52
		1648641·60
(3) Splits, C, D, & E...	2·6618	172484·64
Whole power expended.		1821126·24

Notice here that the two portions, A and B, absorb 90·5% of the power used, and should this be the only power available we can imagine how we should go on as our districts were opened out and more splits required. I am sure the careful student cannot fail to understand that when under such conditions the advantage (from increased ventilation) becomes less the further into the workings we go before splitting.

From the previous example we are taught that if we are to obtain a favourable result from splitting we must have those portions of the airways in which the greatest volume of air travels of greater area than the other portions when a lesser quantity is travelling. For instance, in the sketch given, the portion A should be of greater area than B, because we have in A 64,800 cubic feet passing; whilst in B we have only 43,200 cubic feet.

High velocities are only obtainable at the expense of power, therefore in airways it is better to have not too high a velocity but a fair one, say 12 feet per second or 720 feet per minute in such airways. With this velocity in the portions A and B, find the area of each and the pressure and power required to pass the same quantities as before and then compare the results.

In A we have 64800 cubic feet of air passing, so that with a velocity of 720 feet per minute the area would be $\left(\frac{64800}{720}\right) = 90$ square feet, say 10 feet × 9 feet, find pressure:

$$P = \frac{K\ S\ V^2}{A} =$$

$$\frac{{\cdot}0217 \times 42180 \times {\cdot}5184}{90} = \frac{474{\cdot}49463}{90} = 5{\cdot}27216 \text{lbs.}$$

$5{\cdot}27216 \times 64800 = 341635{\cdot}968$ units of work for A.

In B we have 43200 cubic feet per minute, the area would be $\left(\frac{43200}{720}\right)=60$ square feet, say 10 feet × 6 feet, find pressure:—

$$P = \frac{K\ S\ V^2}{A} =$$

$$\frac{\cdot 0217 \times 38400 \times \cdot 5184}{60} = \frac{431\cdot 97235}{60} = 7\cdot 19953 \text{lbs.}$$

$7\cdot 19953 \times 43200 = 311019\cdot 696$ units of work, B
341635·968 Do. A

652655·664 Do. A & B

	Units of Work.
Power expended on A & B before enlargement	1648641·6
Power expended on A & B after enlargement............	652655·664
Surplus of power left after enlargement	995985·936

This means a saving of about 64% of the former power in A and B which would be available as required when the mine became more extended and more splits required.

The advantage of having those portions of airways wherein the greatest volume of air travels of a larger area than the others has been clearly set forth, therefore in laying out a colliery for ventilation purposes these things should be borne in mind, because the laws of ventilation must be considered if we are to obtain a fair result from the power employed. There are several things which cause a wide difference between practical and theoretical splitting, such as crooked roads, rough and uneven sides, and forcing the air into some of the workings, all these tend to diminish the amount of ventilation.

Fig. 1 is given to enable students to see more clearly and understand why those portions of the roadways in mines which have the greatest volume of air travelling should be larger than the airways in the ordinary splits of the mine, and from this it teaches us two things:—(1) If the airways in such portions are not enlarged we can only produce a good ventilation at great expense of power. (2) When airways are enlarged in these portions we obtain a far greater amount of ventilation with the same power at our command.

With regard to the enlargement of airways in these portions it is sometimes more convenient and of less expense to have two airways instead of one large air-course, but we must remember that the combined areas of the two airways must be such that they will more than compensate for the greater amount of rubbing surface or resistance which will be offered by the two airways to the air passing through, because one large airway has a greater area per unit of rubbing surface than two airways whose combined areas only equal the one large road. There is another matter which I might mention here, and that is at the point where the air joins from a split, instead of allowing the air to meet at right angles it is better to make a curve (fig. 2) and direct the air round the curve by bratticing, timber, or dirt packing, so as to put it into its proper course before the air-currents meet, by doing so the resistance offered to the current is diminished, and the amount of ventilation obtained is increased proportionately.

(*To be continued.*)

AWARDS

For Answers to Competition Questions—No. 18.

Elementary—Jos. Wheatcroft, 8, Longsight Terrace, Kinsley Hemsworth, near Wakefield.

Commended—T. Webster, T. Hewitt, W. Kehoe, J. F. Bradwell.

Advanced—T. E. Aitchison, Green Hill, Dunaskin, Ayrshire.

Commended—W. E. Shaw, J. Crone, H. Hall, J. Stephenson.

First-Class—M. Brown, Butterknowle, Darlington.

Commended—J. Davies, G. Daykin.

Results of Gold Medal and other Competitions given next issue.

Colliery Managers' Examination Results.—The following are the results of the examination held in Yorkshire and Lincolnshire District, on the 25th, 26th, 27th, and 28th June. First-class, 59 candidates, 31 successful, viz, :—Jas. Leigh, Chas. Straw, Hy. Wardell, Wm. Wilson, Wm. Musgrave, Thos. Richards, M. A. E. Bradley, L. C. Larkin, J. Thos. Wilkinson, Jas. Smith, Chas. Sowerly, R. O. Hall, J. Colley, C. H. Elliot, Wm. Finch, J. T. Goodman, Thos. L. Soar, Wm. Heslop, Job Neville, Ed. Purcell, J. Hook, J. Maggs, J. E. Mammatt, A. T. Thomson, J. Ryder, J. Bonser, T. A. Turner, Samuel Turner. The names are given in order of merit. Second-class, 95 candidates, 45 successful.

Readers will please notice that we have made arrangemements with Messrs. W. H. Smith and Son, to supply our Journal at all their bookstalls on order.

ACCIDENTS IN MINES AND THEIR PREVENTION.

HOW much is a miner's life worth? Some may be inclined to resent such a query, but the writer maintains that it is the natural attribute of the obstinate, yea, almost criminal action of many colliery managers during the past ten years. When asked why they do not adopt some definite precautionary measures or alter something which would tend to greater safety,—what reason do they give? That these will increase the cost of getting, a fraction of a penny a ton, and will reduce the yearly dividend by perhaps one-eight per cent. What a miserable excuse, forsooth, when so many lives are at stake! Are several hundred lives to be lost annually in this country alone for such a reason as this? It must not be thought that the primary object of colliery working has been forgotten by the writer, by no means, he is fully cognizant of the fact that collieries are not worked from any philanthropic desire of providing work and wages for the multitude. Colliery Managers should be compelled to do right even if they have not sufficient conscience to dictate it. The following summaries and remarks by Mr. Hy. Hall, H.M.I.M., which appears in his report for 1894, are as conclusive as their necessity is deplorable.

Summary of deaths from explosions of firedamp and their causes; also deaths from accidental ignitions of gunpowder in mines from 1873 to 1893 both inclusive:—

Cause.	Total No. of Deaths.
(1) Candles or mixed lights	1,561
(2) Blasting with gunpowder	1,562
(3) Defective lamps or flame passing gauze	801
(4) Ignited at furnace	20
(5) Cause not stated	266
(6) Accidental ignition of gunpowder	387
Total	4,597

"The totals under the various headings in the summary speak for themselves, and their significance cannot be increased by any word of mine. The aggregate total under the heading of candles and mixed lights show a loss of 1,561 lives, a result simply appalling when we remember that a remedy has been all the time within reach. The second total shows the lives lost through blasting with gunpowder, and to these must be added those due to accidental ignitions of gunpowder shown in the sixth total; these latter are accidents in the *handling* of gunpowder charges, and they are most frequent in mines worked with open lights. We thus have a total of deaths due to gunpowder amounting to 1,949. It would not, perhaps, be quite true to say of this class of accident that a remedy has always been at hand, but that is so now by means of the high explosives such as roburite, ammonite, &c., and whether notwithstanding, gunpowder will continue to be used for the next twenty years, as has been the case with candles, depends upon the character and effectiveness of legislation. In the year 1893, which has now been added to the above lists, the whole of the explosions of firedamp causing the death of 170 persons have been due either to open lights or gunpowder."

In the face of such evidence, the report of the Commissioners is as surprising as it is unsatisfactory. The following is their published report on gunpowder:—

"Having regard to statements made by several witnesses that the abolition of the use of gunpowder would stop the working of many collieries, and bearing in mind the great variety of conditions under which different mines have to be carried on, as well as the various qualities and quantity of dust and the method of working, we do not feel justified in recommending the universal abolition of gunpowder."

Further in their report the Commissioners say:—

"Where an exemption shall have been granted by the Commissioners, and subsequent to such exemption, an explosion takes place which can be reasonably attributed to the use of gunpowder in the exempted or any neighbouring mine, the Secretary of State should have power to place any such mine on the list of those to which the provison for the abolition of gunpowder applies."

This is surely fulfilling the whole adage, "locking the stable door when the horse is gone," it will afford little satisfaction to those injured or to the relations of those killed to know that the Commissioners have only been waiting for such an accident to remove the source. Why not remove the source of evil *immediately* and not after an accident.

The tenor of their statements appears to be that the cost of getting would be increased, and that the margin at many collieries is such

as would not allow of this increase. Now the question of increased costs has been and is harped upon, to a far greater extent than its importance or magnitude occassions. In defence of this statement, Mr. Hall, H.M.I.M., is again quoted. He says, " It is the fashion to assert that mining legislation of recent years has added greatly to the cost of working coal, but this is an assumption not borne out by facts, apart from the indirect effect of the compulsory shortening of boys' working hours upon the time worked by adults, the requirements of the law for constructive work or increased supervision have not added a penny per ton to the cost of getting coal."

We have it on the authority of mining experts that some of the high explosives are as effective if not superior to gunpowder for coal mining, and the cost is very little greater. Even granting that the total abolition of gunpowder would be the means of stopping a few collieries (a circumstance admitting of much doubt), are not the lives annually lost too great to be weighed in the same balance.

As regards the present use of naked lights there is no resource left but to condemn it most emphatically. This question admits of no argument, and the number of years which it has been countenanced is disparaging to the advancement made in other branches of the mining industry in this country.

During the last year ('94) no less than 317 deaths were caused by explosions of firedamp and coal dust, and it is apparent from the individual reports of the accidents that by far the greater number were the outcome of the use of naked lights and gunpowder.

From the number of accidents which have been occasioned during the year by miners' crossing fences, it is evident that the discipline at many places is not as perfect as the circumstances require. The number of prosecutions by the management under this head are by no means in the proportion we should expect from the accidents caused thereby, for one infringement that has disastrous results there are many in which the perpetrators escape unscathed.

In addition to the large number of fatal accidents which occur annually, there are numerous accidents which although causing injury do not result in death. We may estimate the latter at one hundred to every fatal accident.

To reduce the number of these accidents it is absolutely necessary that stringent measures be immediately taken. No half measures are sufficient. The use of gunpowder and naked lights should be universally abolished. Shots should be fired by electrity alone, no other means should be allowed. The firing of shots should be carried out between shifts. Stricter discipline in the mines is necessary; let us have a few more prosecutions by the management, and the number of accidents will decrease.

(*To be continued.*)

COMPETITION QUESTIONS.

We make an uniform award of 2s. 6d. to the sender of the best answer to each of the questions given. Answers to be as brief as possible, and sketches must be made when necessary. One or both questions may be answered.

Envelopes to be marked "COMPETITION," and to reach us before August 9th, 1895.

We invite readers to forward questions for this competition.

(1) Do observations tend to prove that the barometer is of any service as an indicator of danger in a mine.

(2) A simple screw-jack is employed to raise a weight of 5 tons, the screw has a pitch of $\frac{3}{4}$ inch, and the lever is 20 inch long. What power must be applied to the end of the lever? Also find W if P = 50 lbs.

TECHNICAL EDUCATION IN MINING, COUNTY OF WARWICK.—We have received a copy of the examiner's (Mr. A. H. Stokes) report on the above. He states that the whole of the students appear to be of equal value to what has been done in previous years, and shows that the lecturer continues to impart to the students, instruction of a practical and useful nature. The number and class of students examined, and the result of the examination is as follows:—

	Hons.	Advd.	Elem.	Total.
Examined	18	15	22	55
Passed	7	10	19	36

In addition to these five students competed for a £5 special prize.

THE BRITISH SOCIETY OF MINING STUDENTS. — The annual meeting of this society is announced to take place on August 1st, at Armston Colliery, near Edinburgh, at 10 a.m. This colliery will be inspected, as will also the neighbouring one of Newbattle. On the following day the society purpose visiting the Oil Shale Mines of the Broxburn Oil Company at Broxburn.

THE ENGINEERING OF COLLIERIES

Being a Treatise on Colliery Machinery, Appliances, and Constructions.

By T. A. O'DONAHUE.

(COMMENCED IN NO. 9, VOL. III.)

WINDING (continued).

VALVES.—The heavy work which winding engines have to perform necessitates comparatively large cylinders, varying in diameter from 20 to 48 inches, and with a stroke usually twice the length of the diameter. Ordinary slide valves require a great amount of energy to actuate them, and as a principle requirement of a winding engine is that it should be easily and quickly reversed, they are unsuitable for such engines. Various forms of equilibrium slide valves have been designed and in many cases adopted, but they cannot be said to be very satisfactory. The Cornish double-beat valve (fig. 23) is the one most

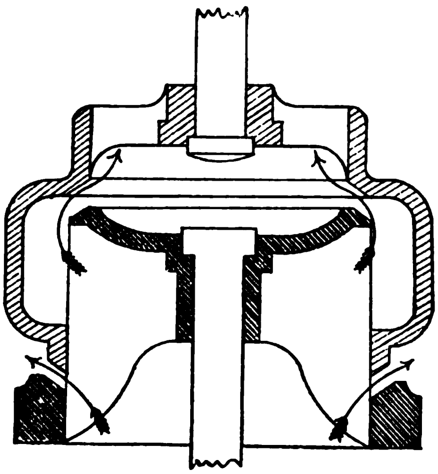


Fig. 23.

generally used, as it possesses the advantages of being almost an equilibrium valve and requires little vertical movement to give a large steam passage. The principle of this valve is clearly shown by the illustration—the lighter shaded portion comprises the valve itself and the darker shading the valve seating. The seating is, of course, immovable, and the valve makes a slight vertical movement which opens or closes it as required. The valve is shown at the top of its stroke, and the cylinder is open to the exhaust, the steam passing through the ports as shown by the arrows.

DRUMS.—The drums or rolls employed for flat ropes are usually only slightly wider than the width of the rope and have horns or guides at intervals on the circumference to ensure the successive coils of rope overlapping each other. The horns are widened out a little at the top, but the part which the rope occupies is only a very little wider than the rope, to prevent the upper coils slipping edgewise down the side of the previous ones.

Three forms of drums have been used for winding with round ropes, the conical, the spiral (fig. 24) and the cylindrical (fig. 21*), the latter being the one most generally adopted. The conical drum was introduced with a view to counterbalancing the engine, but the side of the cone must necessarily be only slightly inclined to avoid slipping, and an appreciable counterbalance cannot be effected. This led to the substitution of spiral drums, which are conical in shape;

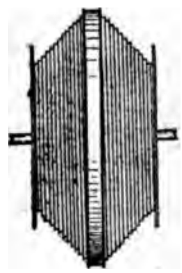


Fig. 24.

but the path of the rope is secured by semi-circular iron troughs or depressions, thus making it impossible for the rope to slip. The centre of the drum is cylindrical, and the last few coils of the rope wrap on this portion, because the troughs take up a considerable lateral space, and in the case of a deep shaft it would require a very wide drum to accommodate the rope. Though not forming a perfect counterbalance the spiral drum is very successful in this respect, but it possesses several great disadvantages. It is very heavy, its first cost is considerable, and it is very inconvenient for banking if cages of more than one deck are used, unless all decks are banked simultaneously. This arises from the fact that the rope which is attached to the cage at the top is working on the largest diameter of the drum while the other rope is working on the smallest, so that if one-sixteenth of a revolution was required to change the position of the decks at the bottom it would be far too great to change the decks at the top, and the engine would have to change three times instead of twice. Taking all things into consideration the cylindrical drum is the best, and if counterbalancing is considered necessary it may be accomplished by other suitable arrangements. The design of drum now generally adopted is not truly cylindrical but the diameter increases slightly towards the centre (fig. 28). This increase in

* See last issue.

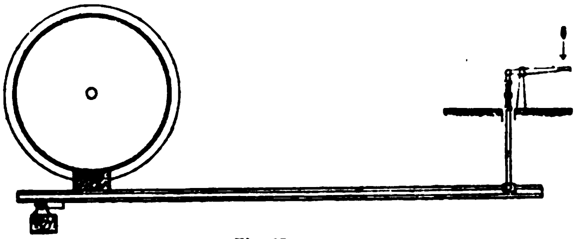


Fig. 25.

diameter is not more than 6 or 8 inches, and is not made with any pretence of counter-balancing, but it is found that the ropes coil better on a drum of this shape.

Brakes.—The C. M. R. A. requires that there shall be attached to every machine used for lowering or raising persons an adequate brake or brakes. The term "an adequate brake," like many other in the Act is very indefinite, but taking an extreme interpretation as applied to winding engines it is one which will stop the engine in any position whatever and hold it there, even against the piston with full steam pressure. Modern winding engines are now fitted with either two brakes, one foot brake, which is worked by the engineman for ordinary circumstances, and a steam brake, which is used when the foot brake is incapable of stopping the engine; or a brake which may be worked either by the foot or steam. *Burns'* brake (fig. 25) is a very efficient foot brake, and consists of a long lever which has its fulcrum at one end and the other end is controlled by the engineman. A short distance from the fulcrum is a block of wood, two feet long, in which are a series of holes containing sand. The block is pressed on the brake rim with a very small movement and the sand prevents it becoming greasy and slipping. A mechanical advantage of 200 to 1 can be obtained on the amount of power applied. Perhaps one of the best forms of brakes adapted for either the foot or steam is shown by fig. 26. It is a strap brake, and encircles about one-third of the lower portion of the brake rim. The brake is moved by a toggle-joint lever, and in case the power applied by the foot is insufficient, steam is admitted to the small piston shown, and this assists the engineman in tightening the brake-strap.

Engine-houses.—As it is part of a colliery manager's or engineer's business to design suitable buildings for the housing of various colliery plant, a few particulars and dimensions of a winding engine-house may be useful. It is understood that elaborate work and magnificient buildings are unnecessary and uncalled for about a colliery, still there is no reason why the erections should not form a pleasing spectatorial view, especially as the cost is not thereby increased. It is doubtful if in any other branch of industry the erections present such an incongruous medley as at a colliery, this is owing in some measure to the inconsistent nature of the work, still much could be done towards giving the whole a more symetrical appearance, instead of erecting buildings in every conceivable position and appearance.

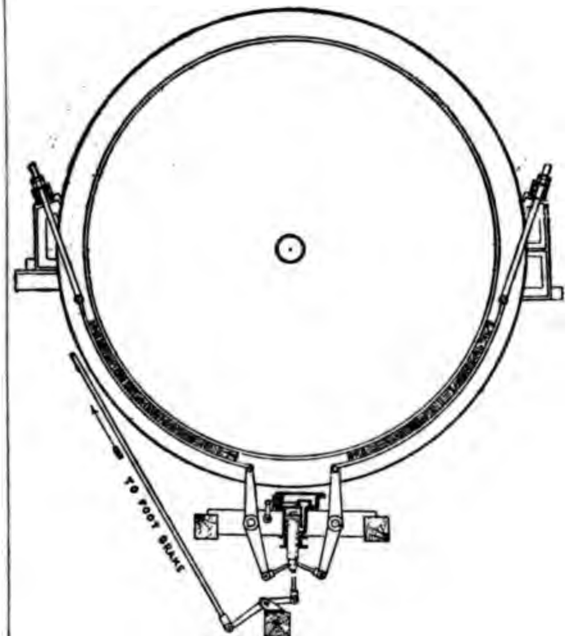


Fig. 26.

A winding engine-house should be very strongly built, well lighted, and roomy. The drum should be placed as high above the surface of the ground as convenient, the engine bed being at least as high as the cage landing. The entrance to the house is usually placed at the back so that the opening of the door will not attract the attention of the engine-man from his work. If the engine is working the engine-man cannot look towards the door without deliberately neglecting his engine, a thing he is not likely to do. The position he occupies is usually along the side of one of the cyclinders, so that the whole of his engine is under his supervision. The window in front of the engine-house should be fixed in such a position as will give the engine-man a direct and clear view of the cages when at the surface landing. Figures 27 and 28 show the eleva-

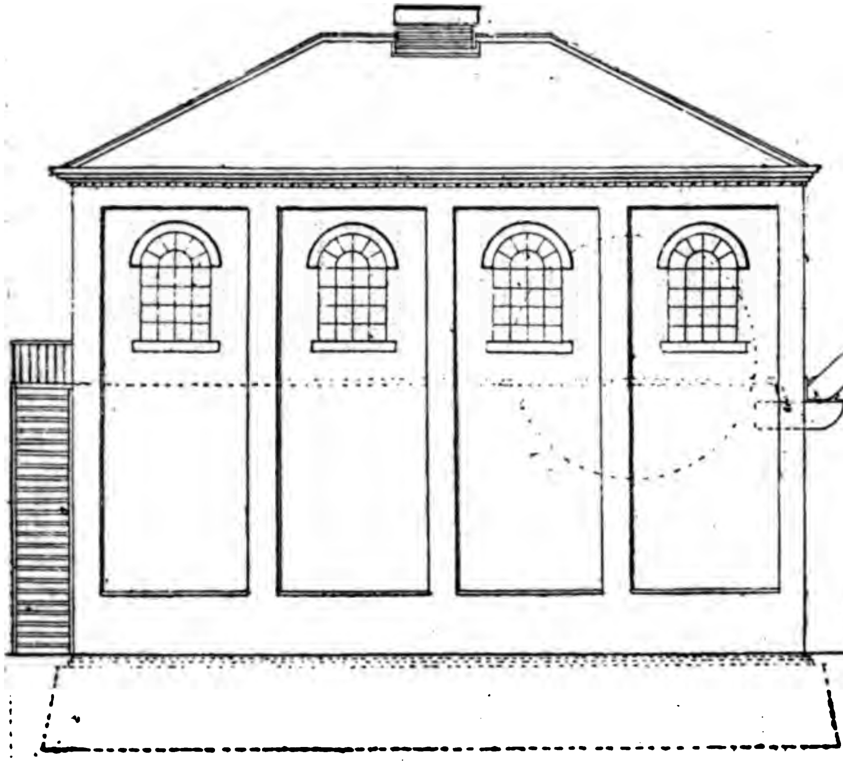
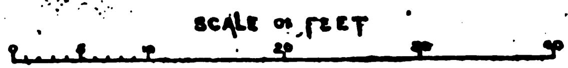


Fig. 27.
Elevation.



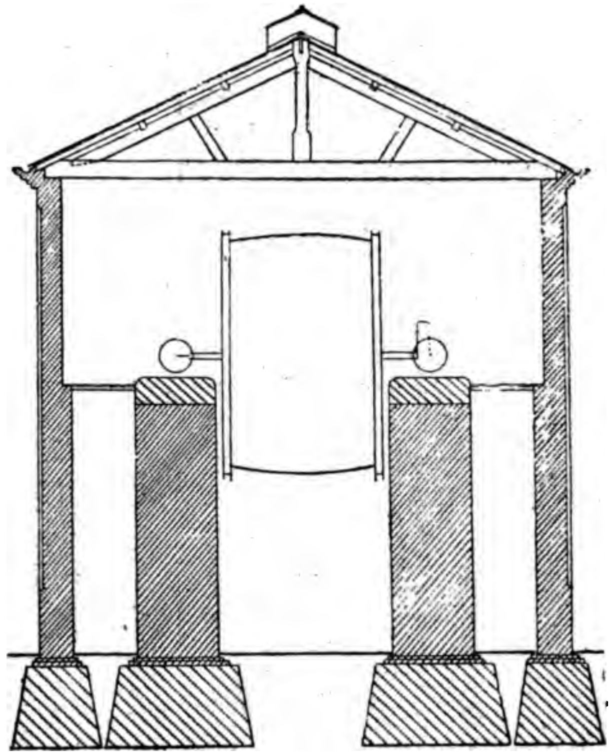


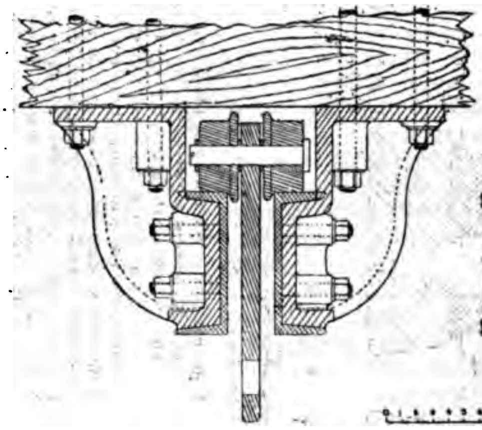
Fig. 28.
Section.

WINDING ENGINE HOUSE.—PRINCIPAL DIMENSIONS AND PARTICULARS

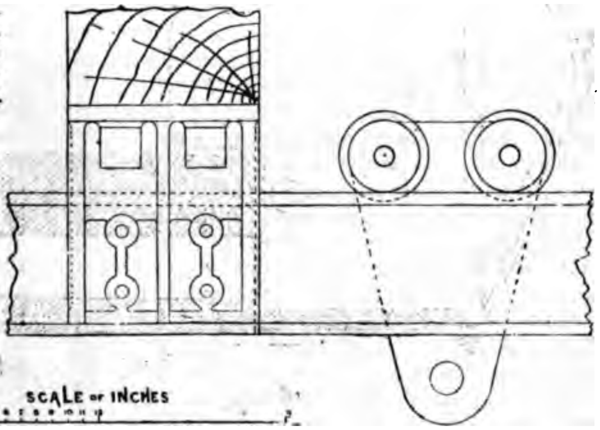
Size of Engines, 30in. by 5ft. Drum, 18ft.
Outside dimensions of engine house, 54ft. by 39ft. 6in.
Height to top of wall plates, 37ft.
Height of ridging above wall plates, 10ft.
Height of engine beds, 21ft., surmounted by stones, 2ft. thick.
Thickness of engine beds, 6ft. 2in. All rubble work, 6ft. deep.
Rubble work for side walls, 4ft. 6in. at top, 6ft. 6in. at base.
Rubble work for engine beds, 9ft. at top, 11ft. at base.
Thickness of side walls, 28in. at ground level.
Distance between engines, centre to centre, 19ft,

Four feet above the floor line the walls are built back 4½in. on the outside, except between the windows, buttresses being here left 2ft. wide, 11ft. apart. The thickness of the walls above the engine house floor is reduced to 18½in., excluding the extra thickness of 4½in. in the buttresses.
Windows, wrought-iron frames, 5ft. by 8ft. Door, 6ft. 6in. by 5ft.
Archways to loading under engines, 8ft. by 10ft.
Floor made with iron chequered plates, supported on iron girders,
The walls for 4-ft. above engine house floor lined with white enamelled brick. Upper portion cemented.

tion and section of an engine-house * built to accommodate a pair of winding engines, 30 inch cylinders, 5 feet stroke, and fitted with an 18 feet drum. The house is built of brick, and as the ground was of a very treacherous nature substantial foundations of rubble work, consisting of the hard rock obtained from the sinking, were built for the walls and engine beds. Access to the loading under the engines is obtained by two archways



Section. Fig. 29.



Side Elevation. Fig. 30.

situated at each end of the building on the ground floor. The space beneath the engine is often made use of as a store room for various purposes, or if the engines are working condensing, the condenser may be placed there, as will also be the cylinder for the steam brake. A subsidary engine or steam crab is sometimes placed beneath the drum in case of accident to the winding engine.

The position of the engine-house depends upon the position of the shaft mouthings underground, and should be placed on the same side of the pit as one of the mouthings. This is not essential, for in many cases the tubs are exchanged from the cage at the side and not at the end, but the latter is much the quicker method.

OVERHEAD TRAVELLER FOR ENGINE-HOUSE. Within recent years a practice which has been proved to be economical and highly useful is to fit up an overhead traveller in engine-houses to facilitate the moving of the various parts of the engine, &c. For large engines, travellers have been fitted up which extended across the full width of the engine-house, and which could be wheeled from one end to the other, so that they could be brought immediately over any object which required moving, and could then deposit it in any other required part of the house. A small traveller such as shown by figures 29 and 30 is usually sufficient, however, and this can be fitted up at very little expense as will be seen from the sketches. The traveller runs on two girders which are supported at intervals of a few yards by specially designed castings, which are fastened below the main beams of the roofing. For the engine-house described two sets of such castings would be necessary. The girders would then be supported at four points, at each end of the building, and at the two castings fastened to the main beams.

(To be continued.)

* The headgear or pit frame shown in figs. 2 and 3 No. 9, Vol. III., was erected in conjunction with this.

ANSWERS TO CORRESPONDENTS.

D. B.—There are many good books on Geometry, you might choose one of the following:—Practical, Plane and Solid Geometry, by H. Angel, 1s. 6d.; advanced books by same author, Vol. I., 4s., Vol. II., 6s., published by Collins, Sons and Co. Geometry (congruent figures) by O. Henrici, 1s. 6d. Practical, Plane and Solid Geometry, by H. W. Watson, M.A., 3s. 6d. The two latter published by Longmans, Green and Co.

J. R. AND OTHERS.—Many thanks for suggestions, they shall receive our attention.

C. S.—Your letter to hand. We do not understand the reason you get our journal so late in your district, and are trying our best to avoid our readers such a great inconvenience. We have advised several of them who have complained of the same thing, to send on their subscription to us direct and we will forward the paper for the specified time each issue.

A. H.—Thanks for your letter of congtatulation. Will write you as early as possible *re* your patent.

ANSWERS TO QUESTIONS.

No. 18 Set—In No. 15, Vol. III.

ELEMENTARY.

Question 1.—Describe a simple method of boring for coal, and state how the section is recorded when solid cores are not obtained.

Answer.—By boring is meant the making of a perpendicular hole of a small diameter in the crust of the earth to ascertain the nature and thickness of the rocks, and is most generally used to obtain information as to the coal measures. A simple method of accomplishing this is to use rods of iron called bore rods. These are generally made of the best iron, of about 1 inch or more in square section, and in varying lengths from 16 to 18 feet. They are connected to each other by the ordinary male and female screw-joints, and at the bottom is attached a cutter or a chisel for the actual boring of the hole. At the top is a double pair of wooden handles called a brace-head, the arms of which are about 18 inches long, at right angles to each other, and firmly fastened to a piece of bore-rod about 18 inches long which is screwed to the top of the bore-rods when working as before stated. To cause the chisel to cut into the rocks two men take hold of the brace-head and raise the rods a few inches, then allow them to drop sharply to the bottom of the hole. In order to make the hole circular each time the rods are raised, the men at the brace-head give them a partial turn in such a direction as will prevent any of the rods from becoming unscrewed. This causes the chisel to drop on a fresh place every time, thus preventing it from wedging itself, and at the same time making the hole circular. The stone at the bottom of the hole becomes broken up into very small pieces by the action of the chisel, and after the process just described has gone on for a short time, the rods are withdrawn from the bore-hole, the chisel taken off and replaced by a cleaning instrument, termed a sludger or wimble. This is lowered into the hole, and being hollow, the debris is worked into it by alternately raising and lowering it. When the hole is sufficiently cleaned the rods are raised to the surface and the wimble taken off, the chisel screwed on again and boring recommenced. As the bore-hole increases in depth additional rods are screwed on at the top. When the boring has reached a depth of 50 or 60 feet, and the weight of the rods has become too great for the men at the bracehead to lift, additional appliances have to be used in order to assist them, such as the rocking-lever. This consists of a wooden lever, about 15 feet in length, provided with an iron axle working in a frame of woodwork. The distance from the top of the bore-hole to the frame forms the shorter arm of the lever, and varies in length with the depth of the bore-hole and the length of the stroke. The end of the lever next the bore-hole is turned in the shape of a sector of a circle, in order to raise and lower the rods in a perpendicular line. At the upper side of the sector is an iron hook to which is attached a short chain from a ring on the top of the bracehead. In order to raise the rods the longer arm of the rocking-lever is weighed down, the men at the bracehead then give the rods a slight turn, at the same time the men at the lever end let go their hold and the weight of the rods gives the required blow at the bottom of the hole, and at the same time pulls the long arm of the lever to its former position ready to be seized again by the men, who repeat the same over and over again until the required depth is attained, or the men have to be assisted by some other power. For the purpose of raising the rods when the hole has to be cleaned or the chisel exchanged, an head-gear has to be erected to which is attached a windlass, or when the bore-hole becomes deep and the windlass is incapable of raising them, a winch may be applied. In very deep holes a steam winch or some other steam engine is necessary to raise the rods. In order to record the section of the rocks passed through, the rods are marked when a fresh stratum is entered, at the same time the contents of the sludger is carefully examined each time it is brought to the surface. This information is recorded in a book, so that at the finish of the boring a complete section of strata passed through has been obtained. Illustrations to the above have appeared in No. 5, Vol. III., of "Mining," pages 63 and 64 respectively.

JOSEPH WHEATCROFT.

ADVANCED.

Question 2.—Describe briefly by means of sketches how levels are timbered in steep seams?

Fig. 1.

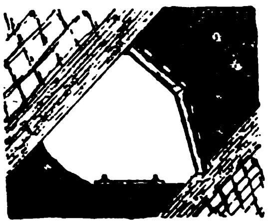


Fig. 2.

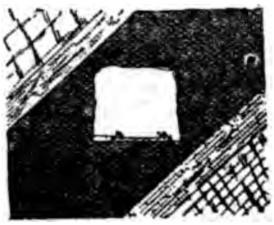


Fig. 3.

Fig. 4.

Answer.—This question is a very important one, and it is very difficult to say how I would timber a steep seam, because a steep seam might be anything from the level to the perpendicular. But I will endeavour to show by sketches how it is done in highly-inclined seams and moderately-inclined seams. As an example say we take the anthracite coal in the United States, which is very thick, with a considerable inclination, and unlike the bituminous coal very hard and rocky. In highly-inclined seams the levels are driven in the coal as shown in fig. 3, and in the rearing seams are driven and supported as shown in fig. 4. Where part of the floor is cut fig. 1 shows how levels are timbered to protect the workmen and also to protect against a fall of the coal. A method of timbering a level in a moderately-inclined seam is shown by fig. 2.

THOS. E. AITCHISON.

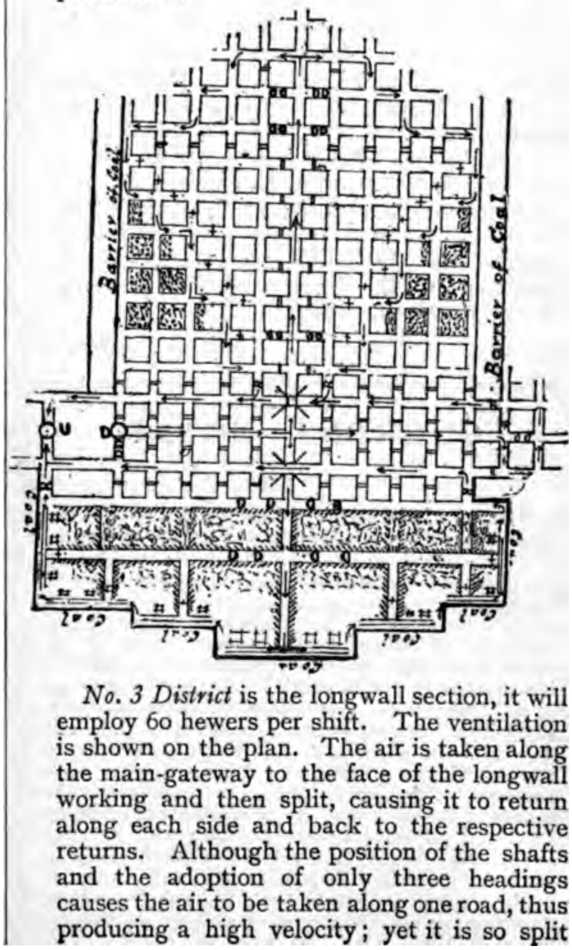
FIRST-CLASS.

Question 3.—A colliery with a hundred hewers in a shift is ventilated by a current of 150,000 cubic feet per minute. Draw a sketch of bord and pillar, and longwall working for it, showing number of workmen in each district, the course of the air splits, stoppings, &c., and give proper dimensions for return airways, also quantity of air in each split.

Answer.—The annexed sketch shows the workings of a comparatively level seam. The workings are divided into three districts namely:—

No. 1 District, in which the whole workings are followed up by the broken as shown, this district will employ 34 hewers, who will be divided as follows—18 men in the whole workings and 16 men in the broken workings. The method of ventilation shown on the plan, is that of conveying the air from the whole on to the broken. This method may be improved upon, should the broken or whole workings give off much gas, or if it should be necessary to supply each respective flat with fresh air. The proportionate quantity for this district is 75,000 cubic feet per minute, which may be split as the circumstances presented may determine.

No. 2 District is a new winning, and will employ 6 hewers, the ventilation is so arranged as to favour it being supplied with fresh air, which is an important item regarding the efficient working of main headings or winnings. Its proportionate quantity is 5,000 cubic feet per minute.



No. 3 District is the longwall section, it will employ 60 hewers per shift. The ventilation is shown on the plan. The air is taken along the main-gateway to the face of the longwall working and then split, causing it to return along each side and back to the respective returns. Although the position of the shafts and the adoption of only three headings causes the air to be taken along one road, thus producing a high velocity; yet it is so split

that when it returns its velocity is much reduced, and the velocity of the vitiated air is of the greatest importance. The quantity of air for this district is 70,000 cubic feet per minute.

Dimensions for Return Airways.—Omitting the increase of quantity due to expansion caused by heat, the quantity returning from No. 1 and No. 2 Districts is 80,000 cubic feet per minute. This quantity will necessitate the main return airways to be 10 feet square for the longwall main return the size necessary will also be 10 feet square, but this size would only be necessary from the point where both the return currents join, the size adopted for minor returns if convenient should be 7 feet square. The roadways are 4 yards wide and pillars 30 yards square which are to a scale of $\frac{1}{12}$th of an inch equals 4 yards. Size of pillars, $\frac{2}{10}$ths of an inch equals 30 yards, hence the pillars are left 30 yards square; there is about 900 yards of longwall face shown on the plan, this will equal 15 yards of face per hewer. But of course the whole of this face will not be kept proceeding by 60 men at the same respective time, unless it is favourable for the adoption of coal cutters; but it is essential to efficient working to have ample face room, so as to meet any emergencies. At Pemberton Colliery there are four men to each stall of 30 yards. But the whole proceedings will be modified by the local conditions presented in and about the mine.

MYLES BROWN.

CURRENT NOTES.

MINING ON AN ISLAND IN THE FIRTH OF FORTH.—Operations have recently been in progress by Messrs. Hutton and Son, on the Preston Island, an island in the middle of the Firth of Forth, opposite Bo'ness and Culross, in the hope of being able to re-open pits which were sunk on the island early in the present century. Sir Robert Preston spent £30,000 on the island in sinking three shafts, fitted them up with the best machinery which could be obtained in the days of early mining, erecting houses and building a pier. Sir Robert had only begun to open up the minerals when a firedamp explosion occurred, and the concern was abandoned. When the Messrs. Hutton took possession of the island the sea was washing over the mouths of the three pits. They repaired the retaining walls and carried out some puddling with the most satisfactory results, and erected a small pumping engine on the original pumping pit. All through it has been apparent that the pump had only the natural growth in the mine to contend with—no sea water—and in a very short time the pits will be clear of water. The explorations already show that the pumping pit had been sunk to a depth of 46 fathoms, and in this short distance four workable seams of coal are exposed. One of the seams is 9 feet thick, and the seam 12 fathoms under this is 5 feet in thickness. Under this again the well-known Fife seams, the "Five-foot" and "Dunfermline Splint," are known to be lying whole. There is a depth of 13 feet of water surrounding the old pier built out from the island by Sir Robert Preston, so that the shipping of coals will be an easy matter.

* * *

NEW COAL-WORKING AT BRADLEY GREEN.—For many years it has been a settled belief of those living in the neighbourhood of Bradley Green that coal was to be obtained of a quality, and sufficiently near the surface, to be remunerative if worked. This opinion was shared by experts who examined the place, and was justified by recent boring trials. A company or syndicate was formed, the officials of which met a few days ago, and selected a spot on which to commence operations. Workmen have arrived, for whom lodgings have been engaged and buildings erected, and the work is expected to be in full swing this week. The borings are about four miles from Redditch, near Bentley Manor, and if the experiment turns out successfully it cannot fail to have an important beneficial effect upon the commercial life of the district.

* * *

THE TINSBURY COLLIERY EXPLOSION.—Two reports were issued last week on the circumstances attending the above, which occurred on the 6th February, 1895. The first report is by Mr. J. Roskill, Barrister, who attended the enquiry on behalf of the Home Office, and the second is by Mr. Jos. S. Martin, H.M.I.M., who is of the opinion that the explosion was one of coal dust caused by direct ignition of the dust during the firing of a shot. The substance of his report is as follows:—Naked lights have been used for all purposes ever since the collieries were first commenced, 70 years ago. Fire-damp (CH_4) and carbon monoxide (CO) as well as other explosive gases have been absolutely unknown in this mine. Previous to the explosion the mine did not appear to be very dry and dusty, but a certain amount of watering had been carried on. Powder has been the explosive exclusively used, squibs, motes or straws, and fuse have been used for firing the shots, and all qualified colliers have been looked upon as competent persons to fire shots. It is agreed that the origin of the explosion was the shots fired by Carter in the through road. The shot was in the roof and the hole had been drilled several years previously. A close joint ran across the end of the hole entirely cutting the charge off from its work. Mr. John Batey, Mining Engineer, of Coleford, near Bath, gave it as his opinion that the explosion was caused in the first place by a flame from the shot igniting inflammable gas in a cavity which existed in the roof of the road about 6 yards inwards. That the inflammable gas may have been CH_4 or CO, or both. That one or other or both of these gases may have existed in the old workings on the lower side which have been standing for 36 years. That CO may have collected there from the products of combustion of powder used in proximity a few days before. For his own part, however, Mr. Martin has no hesitation in fixing upon dust, ignited by the overcharged shot, as the source of the whole damage.

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MINING

A JOURNAL DEVOTED TO THE INTERESTS OF MINI[N

[N]o 19. Vol. III. SATURDAY, AUGUST 10, 1895. FORTNIGHTLY. ONE PENNY.

CONTENTS.

THE ENGINEERING OF COLLIERIES

Being a Treatise on Colliery Machinery, Appliances, and Constructions.

By T. A. O'DONAHUE.

(Commenced in No. 9, Vol. III.)

WINDING.—CONTINUED.

COUNTER-BALANCING.—When winding with drums of constant diameter the engine is subjected to an ever varying load, and in many cases at the end of the wind the load is actually a negative one. To make this clearer let us take a possible example of a shaft, 600 yards deep, winding three tons of coal per wind with a rope weighing 12lbs. per yard. The weight of the tubs, cages, and bridle chains need not be taken into account, as the descending cage and tubs will counter-balance the ascending cage and tubs. The load on the engine at the commencement of the wind is, therefore, the three tons of coal plus the weight of the rope hanging in the shaft, or—

3 tons of coal = ...	6720 lbs.
600 yds. of rope, at 12lbs. per yd.	7200 ,,
Total load............	13920 ,,

Towards the end of the wind all the weight of the rope is in favour of the descending cage, and as this is greater than that of the coals being wound there is a considerable weight assisting the engine and the load is practically negative, thus:—

Weight of rope......	7200 lbs.
Weight of coal......	6720 ,,
Negative load = ...	480 ,,

It is, therefore, apparent that the work done by the engine is ever varying, and that at the commencement of the wind there is a considerable load to be started, thus necessitating large engines. It is possible, however, to equalise the load over the whole operation of winding, and the work can then be done by a very much smaller engine.

There are several methods of counter-balancing the engine in use, viz., conical and spiral drums, flat ropes, pendulum balance chain, tail rope, and balance rope.

A further consideration of the adaptability of conical and spiral drums and flat ropes for counter-balancing is unnecessary as their respective merits and demerits have been previously discussed.

The pendulum counter-balance (fig. 31) is only suitable for shallow shafts in which connter-balancing is scarcely necessary, so that it is seldom used. It consists of a

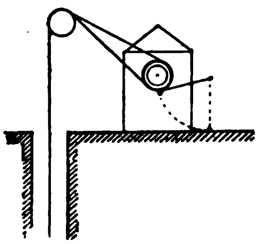


Fig. 31.

weighted pendulum, which makes two quarter revolutions, backward and forward in the course of a wind. The pendulum is horizontal when the wind commences and the full weight is assisting the engine. As the winding proceeds the pendulum falls, and this throws part of the weight on the point of suspension, until at the cage meetings it becomes perpendicular and the whole weight is supported by the rod. During the latter half of the wind the pendulum is again raised to the horizontal and the weight is acting against the engine.

A much better counter-balance, though not always convenient or economical, is the chain and staple. A small drum is fixed to the drum shaft of the engine, and on this coils a rope which is connected to a number of heavy chains, which are suspended in a staple pit, perhaps 50 yards deep. At the commencement of the wind the full length of chains is suspended in the staple pit, but as the winding proceeds the chain gradually rests on the bottom. When half the wind has been performed all the chains are resting on the bottom, and as the full length of the rope by which the chains are suspended will be then given out it commences to coil on the drum in the contrary direction, and during the latter half of the wind the chains are raised again. By this means there is a constant decreasing weight in favour of the engine during the first half of the wind and a constantly increasing weight acting against it in the last half.

The tail rope under cages appears to be the best method yet adopted for equalising the load on the engines, and there is only one objection to its use, namely, the extra strain put on the capping of the winding rope, by reason of the additional weight of balance rope which it has to sustain. The rope is fastened to the bottom of one cage, then passed round a pulley in the sump at the bottom of the shaft, and the end is attached to the bottom of the other cage. If the tail rope is of the same weight per fathom as the winding ropes the load on the engine is equalised throughout the whole of the wind. The sump pulley is usually placed in guides and weighted slightly to prevent the tail rope becoming too slack, but if the rope is a flexible one the pulley may be discarded altogether, as it is sufficient to pass the rope under a cross-bearer.

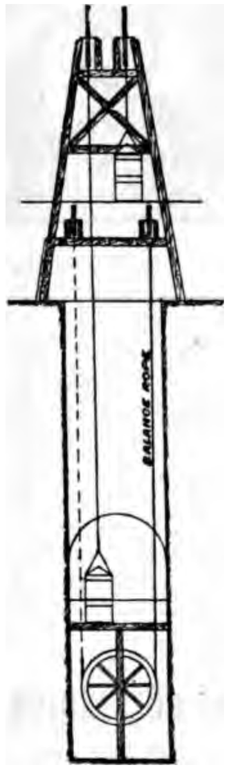


Fig. 32.

A special arrangement of balance rope (fig. 32) has been employed by Mr. C. Meinicke, whereby the weight of the rope is not supported by the winding rope, and the strain is in consequence taken off the capping. This is affected by attaching the balance rope to two auxiliary ropes instead of to the bottom of the cages. The auxiliary ropes pass over special pulleys provided for them at the surface, and are then wound on a portion of the main drum itself or upon auxiliary drums keyed on to the main drum shaft. The balance rope is made sufficiently heavy to counter-balance both the winding and the auxiliary ropes, and as it has not to be in any particular position in the shaft it may be boxed off, which is a great advantage in some cases.

Special Methods of Winding.

Blanchet's Pneumatic System.—This system of winding, or more correctly hoisting, which was proposed by Mons. Z. Blanchet, and carried out by him at the Hottingeur shaft, Epinac, France, is somewhat on the same principle as the pneumatic tube used in the postal and other departments. The shaft was 18 feet diameter and over 700 yards deep. It was intended to sink it to 1100 yards, but no workable coal was found, and although the success of the pneumatic system was assured, as some work was done with it, yet as the work for which it was intended was not forthcoming it was never used to any practical extent. Apparently the working cost differs little from that of ordinary winding, but the first cost of the plant and erection was enormous. The following is an account* of the installation and arrangement:—

*Abbreviated from description by T. W. Bunning (N.E.I., xxiii).

A cylindrical tube, 63 inches diameter and about $\frac{5}{16}$ of an inch thick, made of plate-iron, rivetted together with butt joints and countersunk rivets, runs from top to bottom of the shaft. It is made in 20-feet lengths and joined together by means of flanges and bolts. They were made truly cylindrical by hammering on a mandril, although at first it was thought that the tube would have to be bored. The tube is put in a special compartment of the shaft, from the sides of which it is isolated. It is supported every 10 feet by buntings similar to those used for supporting the pumps.

The piston is made in two parts, one at the top and the other at the bottom of the cage. The top piston is made of two platforms, at such a distance apart, that in passing by the doors to admit the tubs one shall always be in an uncut portion of the tube, in order that the pressure shall be constant when the piston is passing these doors. The lower part of the piston below the cage is made of one platform, and in this is fixed a valve, which can be opened whenever men are riding to afford them necessary air for breathing. It also carries a centrifugal parachute (A) to prevent the too rapid descent of the cage in case of accident. The top plate of the piston carries a spring buffer (B), which diminishes the shock when the valve (C) is struck by the ascending piston. The cage (D) is made in the usual way, and is constructed to hold nine tubs, of about 10 cwt. capacity, one above the other. The total weight of piston, cage, tubs, and coal is about 12 tons, which is equal to about 8·4 lbs. on the square inch of the tube. When the pumping engine has reduced the pressure of the air above the piston to $15 - 8{\cdot}4 = 6{\cdot}6$ lbs. per square inch, the cage will commence its ascent with a speed dependent upon the speed of the exhausting cylinders. These exhausting cylinders are 108 inch diameter and nearly 10 feet stroke, and the engine makes 10 strokes per minute, thus making the time of ascent about $2\frac{1}{2}$ minutes. When the piston has to descend the exhausting from the tube is stopped by means of doors or valves (E), and the air is allowed to press upon the top of the cage by means of the regulator (F), so that its pressure can be augmented until it reaches the point where it will cease to sustain the weight of the cage without the coal. Valves and doors are so arranged that the air is taken up from the return air-course on the ascent of the piston and delivered outside the mine on its descent through H.

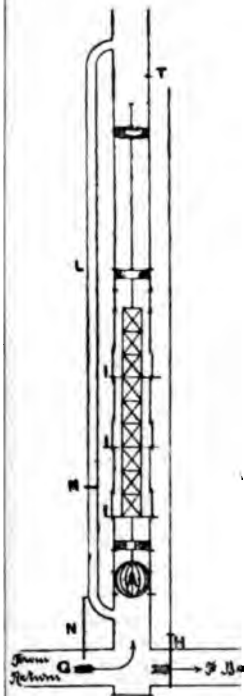


Fig. 33.
Section at bottom of shaft.

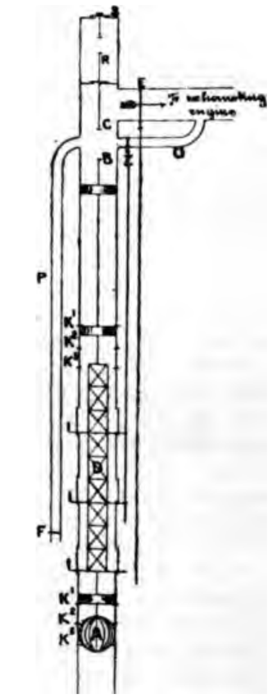


Fig. 34.
Section at top of shaft.

In order to get the tubs in and out, three double doors (I I I) are cut in the tube, both at top and bottom, and these correspond to three levels of the heapstead. Three movements of the cage are therefore necessary to change the tubs, and the cage is maintained steady and in the proper position by keps or stops (K K K). At the bottom of the pit the equilibrium pipe (L) goes from the bottom to a point sufficiently high to be above the piston during the whole time the tubs are changed, and when the cock (M) in this pipe is shut, the pressure in the bottom keeps the piston up against the stops. When the cage descends it forces air from the bottom of the tube through the escape valve (H) to the surface. To stop the piston in its descent at the bottom the escape valve is shut by the cage at T, and the air at the bottom of the tube is compressed.

The quantity could be doubled by having another tube connected with the first without increasing the power of the engine, which would work with less resistance in drawing the air from the top of the ascending piston and letting it on the top of the descending piston, instead of into the atmosphere; this would also better the ventilation.

(To be continued.)

EASY LESSONS ON

MINE VENTILATION.

By J. CARTER, First-Class Certificated Manager.

(Commenced in No. 9, Vol. III.)

SPLITTING OF AIR-CURRENTS.—Continued.

THE velocity of the air is a very important item in the ventilation of mines, because if too high we obtain it at the expense of power, and if too low the current becomes too feeble to remove the deleterious gases which are given off in the mine, thereby rendering the mine dangerous. If an ordinary Davy lamp be used the greatest velocity should not exceed 5 feet per second, because in the return air-courses where the air is likely to be mixed with firedamp, and if mixed in so great a proportion as to render it explosive, then any further increase becomes dangerous, because the flame of an ordinary Davy lamp, at 6 feet per second, will pass through the gauze, therefore the Davy lamp would be unsafe in such a velocity if the air-current were at an explosive point. But with our modern lamps, such as Mueseler, Marsaut, and others of a similar type, we are enabled with safety to increase the velocities even when charged with an explosive mixture. Yet with these it is better not to have too great a velocity for the reason of the amount of power absorbed. However, it is not always practicable to reduce the velocity of the air-currents in the up-cast shafts and returns to a minimum, though our desire to do so may be great. It is also very important that the air travelling in the working parts of the mine should not travel at less than 2 feet per second or more than 8 feet. Although a much greater velocity than the above is obtained in many of our modern collieries, yet to overcome this increased velocity they have to lay out for power accordingly. In order to point this out more clearly I append the following table:—

Velocity in feet per second.	Relative Pressure.	Relative Power.
2	1	1
3	2·22	3·5
4	3·94	8·28
5	6·15	16·17
6	8·85	27·94
8	15·73	66·22
12	35·39	223·49
15	55·29	436·51
20	98·9	1034·69

I may here point out that by ascensional ventilation (when it can be carried out) we obtain a better result than otherwise. By ascensional ventilation we mean the art of conducting the air underground so that it shall first go directly to the lowest part of the mine workings and rise as it returns to the bottom of the upcast shaft (see sketch). The reason this method is better is because there is a loss of power when the return air is conducted downwards to the upcast shaft. Quantities of air that will pass in different splits in the same horizontal plane are found in practice to give the same proportion whatever the ventilating pressure may be. This is not the case with a dip split and a rise split, owing to the natural influences of the mines being at work, such being in our favour in a dip split, because the return air is lighter, owing to different temperature of gases which are given off in the mine (except CO_2), all tend to rise, therefore with the return ascending it is in our favour, and against us in the rise split.

If a dip and a rise split be subject to one common pressure, to the dip split there must be added the pressure due to natural influences, and in the rise split these influences must be deducted. Should we have two splits, a long and a short one, on a horizontal plane, in order to pass equal quantities we should require a regulator to be erected in the short split, and on reducing or increasing the ventilating pressure the quantities will still be in the same proportion as with the original pressure, but if the long one was a dip and the short one a level one, on reducing or increasing the pressure (or quantity of air), the long split will get a greater proportion than it had originally. On the other hand, if the long split is a rise and the short one a level one, on reducing the total quantity of air the long split would pass less in proportion to its original share and the short one gets more. In practice this has been proved so often that it shows clearly the value of ascensional ventilation. Should the returns be so mixed with CO_2, and so cool as to be more dense than the intake air, we should have results the reverse on increasing or decreasing the ventilating pressure when the splits are not level. This is rather exceptional, as it is generally the case that the returns are less dense in consequence of the heat naturally given off by the strata and other sources. Therefore, in collieries it is better to have the return air-course on the upper side of the workings, as by this means

gases given off will be naturally drained from the goaves or where the men are employed.

In furnace ventilation the furnace should be placed on the dip side of the shaft, because we obtain thereby a greater motive column and consequently better ventilation. In fiery mines, furnaces when employed must be fed with fresh air and all the return must be sent to the upcast shaft by means of a dumb-drift

In laying out a colliery for ventilation we must take into account the number of men employed, lamps to be used, probable number of horses, and in fiery mines an account of the quantity of coal raised per day. If we take the number of men employed and allow a large amount of air per man, say 500 cubic feet per minute for a 5 feet seam, or 600 cubic feet in a 6 feet seam, we should have a good average and an average which is recommended by many of our mining authorities. In a mine employing 450 men and boys below ground the quantity of air required per minute would be :—

450 men and boys, 450 × 500 =	225000
480 lamps (12 cubic feet per lamp) 480 × 12 = ...	5760
12 horses (600 cubic feet per horse) 12 × 600 = ...	7200
Total...............	237960

I have taken into account very few horses, because hauling in our modern mines is such that few horses are required. Also I have not taken into account explosives used for the reason that in extensive and fiery mines the shots are fired when very few men are in the mine, which is chiefly in the night, therefore this may be left out with safety.

This is the question which every mining student should inquire into, and he will find by some it is allowed that 100 cubic feet of air per man and 600 cubic feet per minute per horse will keep a mine in good condition. But the greater evidence will be that no mine which yields much firedamp can be considered ventilated efficiently unless provided with from 200 to 600 cubic feet per man per minute, and the greater quantity per man should be in those mines or seams of greater thickness, viz., for a seam, 2 feet thick, 200 feet per minute, and add an additional 100 feet per man for each foot of increase in height of seam, and if calculated according to the above there is no fear of being inadequately ventilated

(To be continued.)

NOTE.—The article on "Accidents in Mines and their Prevention" has unavoidably been held over until next issue.

ANSWERS TO QUESTIONS.

No. 19 Set—In No. 16, Vol. III.

ELEMENTARY.

Question 1.—State clearly what is meant by the specific gravity and symbol of a gas. Of what use is a knowledge of these?

Answer.—The specific gravity of a gas is its weight in comparison with an equal volume of air. Thus the weight of air being taken as unity, an equal volume of carbonic acid gas would weigh 1·528. If, supposing, we take three flasks of equal weights and dimensions, and fill them with air—carbonic acid gas and firedamp respectively—and then weigh them separately, we find that if the weight of the vessel containing the air equals 1lb., the weight of that containing the carbonic acid gas will equal 1·528lbs., and that of firedamp ·555 (*i.e.* neglecting the weights of the vessels themselves.) We see by this that the specific gravity of firedamp is only a little over half as much as that of air, and also that the specific gravity of carbonic acid gas is half as much again. By having a knowledge of the specific gravity of gases, we have a better idea where to look for them when making inspections in a mine, and also to ascertain what kind they are. We see that by firedamp only being about half as heavy as air it will make its way to the highest point in the roadways and workings of a mine; but owing to carbonic acid gas being half as heavy again, it acts on the reverse and seeks the lowest point. A rule given to find the specific gravity of gases, is to divide the density of the gas by the density of the air, thus the specific gravity of carbonic acid gas equals $\frac{22}{14{\cdot}4} = 1{\cdot}528$ nearly. Symbols are letters which represent atoms of different elements. In the case of simple gases the first letter of the name is usually taken to represent the atom; but when two or more elements have the same initial letter, another letter is added in order to distinguish them. It will be noticed that some of the symbols do not correspond with the names of the elements apparently. This is explained by the fact that the symbols are taken from the latin names of the elements. The symbols also represent definite weights of the respective elements. A list of symbols and atomic weights of the elements given here:—

Names of Elements.	Symbols.	Atomic Weights.
Hydrogen......	H	... 1
Carbon.........	C	... 12
Nitrogen	N	... 14
Oxygen.........	O	... 16
Sulphur	S	... 32
Zinc	Zn	... 65
Lead............	Pb	... 206

Compounds as well as elemente may be represented by symbols, for instance, CO_2 represents a compound containing one atom of carbon combined with two atoms of oxygen, and from its formula we also gather that there are 12 parts by weight of carbon vapour combined with 32 parts by weight of oxygen, forming 44 parts by weight of carbon dioxide, commonly called black-damp. We must first have a knowledge of the symbols and atomic weights of gases before we can ascertain their specific gravities.

JOSEPH WHEATCROFT.

Question 2.—How are bits and borers tempered and sharpened for boring by hand?

Answer.—The drill or borer is placed into a fire made purposely for this work until it has attained a blood-red heat, it is then drawn out and hammered to the size and shape required. In the process of tempering steel, if the skin of it be clean, there are certain colours seen which denote the molecular changes going on at different temperatures. By slowly heating a bar of steel a wave of straw colour will be noticed passing over its surface, on a further increase of temperature the straw will change into a purple colour, and by still further heating the purple will change into a blue colour. Now each of these colours denote a certain degree of hardness, the straw being very hard, the purple less so, and the blue moderate hardness, that is if the bar be suddenly cooled immediately the particular colour is seen. In cooling, the tool is plunged into water and worked backwards and forwards and up and down, for if the tool is kept still in the water, a line of fracture is produced coinciding with the surface of the water. If this was the case the tool would break off at this line when put to use. Coal-tar is a great deal better than water for this purpose, owing to it being a bad conductor of heat, and being thus less liable to produce a line of fracture. JOSEPH WHEATCROFT.

ADVANCED.

Question 3.—Explain the theory of the ventilation of mines, and why artificial ventilation is more reliable than natural?

Answer.—The theory of mine ventilation? When we talk about mine ventilation we mean that a regular supply of fresh air be kept up to remove and take the place of the impure air that is generated. The air of a mine is rendered impure by—

1. The breathing of men and animals.
2. Blasting operations.
3. Combustion of lamps, &c.
4. The various gases given off at the face.
5. Watery vapour.
6. Coal dust.
7. Underground or gob-fires.

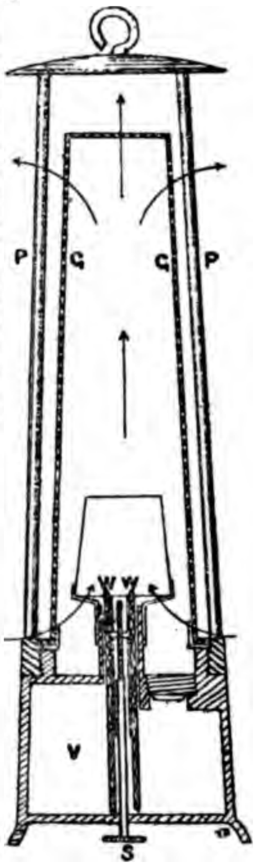
To preserve the health of the body a pure atmosphere is necessary, therefore some means must be adopted so that this impure air which is prevalent in mines be removed, and fresh air conveyed to fill its place. This supply of fresh air should be constant as it is soon rendered impure, and must be driven out to keep the mine in a fit condition for the persons working therein. Natural ventilation depends chiefly upon the surface, which is very variable, therefore not to be relied upon for the ventilation for mines. It only produces a small current when at its best, and this may be reduced, stopped, or reversed by a change of surface temperature or direction of the wind. The most dangerous feature is the reversal of the air, for noxious gases may be in the returns at the time, these would be driven into the working places and intakes and might produce fatal results. Therefore I would say artificial ventilation is most reliable because it never changes its course, the current is not reduced unless necessary, neither is it stopped when there are men in the mine, unless some unforseen accident occurs. One shaft is the downcast both summer and winter, the other the upcast. The impure air is drawn out by some artificial appliance such as the fan or furnace, while the fresh air rushes down to fill the vacuum caused by the removal of the impure air.

JOHN STEPHENSON.

Question 4.—Describe the Pieler and Clowes methods of testing for gas?

Answer.—Owing to a less percentage of fire-damp in air than $2\frac{1}{2}$ per cent (which may be detected by any ordinary safety lamp) being dangerous where coal dust exists, a much more sensitive detector than the safety or ordinary Davy lamp is desirable. The Pieler lamp has been introduced for this purpose, and is used exclusively for testing the air in mines. It is very similar to a Davy lamp, but is constructed to burn alcohol with an Argand or open circular wick, the air is supplied to the inner part of the flame, and enters from the bottom by a tube which passes vertically through the vessel which contains the alcohol. The opening of this tube is protected by superposed discs of gauze. Around the flame is a short conical chimney, open above and below, and the flame is so regulated that it does not appear above the chimney, the height of which is from 1 to $1\frac{1}{2}$ inches. The lamp is inclosed in a tin cylindrical case from which a section is removed, and in which

Prof. Clowes' Hydrogen Lamp.



Pieler Lamp.
REFERENCES.—
V—Oil Vessel W—Wick
S—Screw G—Gauze
P—Pillars

a graduated strip of glass is fixed. The flame is extinguished by the ignition of the gas in the lamp. The following percentages of fire-damp in air give the various heights of flame cap:—

$\frac{1}{4}$ per cent. of fire-damp gives a cap $1\frac{3}{8}$ ins. in height.
$\frac{1}{2}$ " " " " 2 "
1 " " " " $3\frac{1}{4}$ "
$1\frac{1}{2}$ " " " " $4\frac{3}{4}$ "

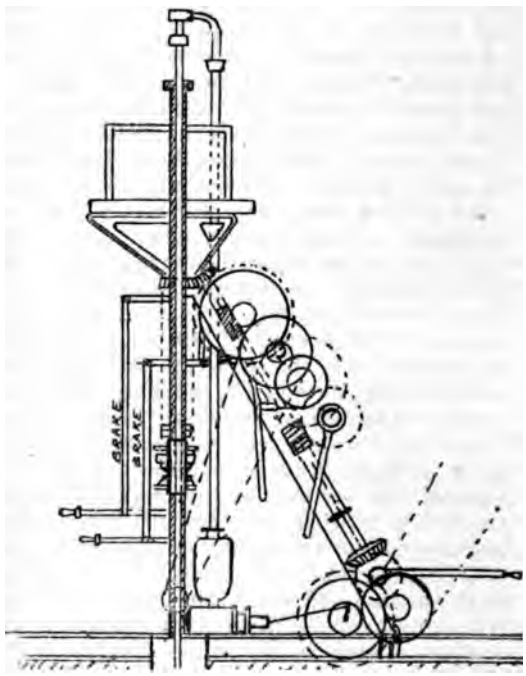
so with 1¾ per cent. the cap reaches the top of the lamp. Chesneau has in some respects improved the Pieler lamp. The caps yielded by percentages of gas less than one are rendered more easily perceptable by introducing copper-salt into the alcohol which is burnt, and the lamp is stated to be safe even in the presence of much gas; but it has one small disadvantage of the Pieler, that it cannot be set with accuracy to a standard height when it is used for measuring the percentage of gas present, and low proportions of gas cannot be identified with certainty.

CLOWES HYDROGEN FLAME TEST.—Professor Clowes, of Nottingham, has recently rendered possible and convenient the use of a small standard hydrogen flame in any ordinary form of safety lamp. He secures this by arranging the lamp to receive an attachable steel cylinder of compressed hydrogen gas. The lamp burns oil from its reservoir in the usual way, and this oil flame can be reduced in size and employed for detecting and measuring proportions of gas varying from 3 to 6 % in the ordinary way by observation of the flame cap. But the lamp can also be converted, when desired, into a delicate and accurate indicator of proportions of gas varying from 0·25 to 3 %. To effect this conversion it is only necessary to attach the hydrogen cylinder to the lamp and gradually open the valve. The hydrogen jet is then fed from a metal jet near the oil-flame of the flame. The hydrogen kindles, and the oil-flame is then extinguished by drawing down the wick. The hydrogen-flame is adjusted to exactly 0·4 inch in height against a scale fixed within the lamp, and this standard flame is carefully examined for a cap. The cap, if seen, is measured against a metal scale fixed in front of the flame, and seen as a black opaque object against the background of the flame and cap. Even an inexperienced observer can thus at once see and measure gas down to 0·25 % or even down to 0.1 % if required. When the hydrogen test is finished, the wick is pushed up and becomes kindled at the hydrogen flame. The lamp thus becomes once more an ordinary lighting lamp, and when the hydrogen is turned off, and the cylinder detached, the lamp is in its ordinary position again. The process of converting the oil-flame into a hydrogen-flame, making an estimation of gas, relighting the oil-flame, and detaching the cylinder, can be easily carried out in a few seconds. The small cylinder for compressed hydrogen is made of best steel, and it weighs a little over three-quarters of a pound. It is usually charged to about 1,500 lbs. pressure per square inch, and can furnish the standard hydrogen flame, burning continuously, for upwards of two hours. Its safety is secured by testing it always to 3,000 lbs. pressure, and it is proved to yield only under 7,000 lbs. which is a little over 3 tons. It is charged by connecting it with one of the ordinary large steel cylinders of compressed hydrogen. This small cylinder when attached to the lamp forms a most convenient handle for supporting the lamp.

THOMAS LAWRENSON.

FIRST-CLASS.

Question 5.—Describe and illustrate the usual surface arrangements for diamond boring?



Answer.—The accompanying sketch shows fully the usual surface arrangements for working the diamond borer. The following is an account of the above boring machine as given by Mr. Henry Davis. The diamond is applied to rock boring by putting a number of stones, viz.:—Black Brazilian diamonds, and setting them in the edge of a steel cylinder or crown to which the rods are attached. The crown in

which the diamonds are set is screwed on to the end of steel tubes which serve as rods for transmitting motion from the surface. These tubes or hollow rods terminate at their upper extremity in a universal clutch which allows them to turn, and is connected with a cross-head sliding between two vertical uprights. A rotary motion is communicated to the rods by means of suitable gearing and engine as seen on the sketch. The speed of rotation is usually about 250 revolutions per minute. The weight upon the crown which is made to vary according to the hardness of the rock and the rate of progress required is from 400 to 800 lbs., and is furnished by the increased length of the rods or diminished by a counterweight according to the depth attained. During the progress of boring, water is forced down the hollow rods to remove the debris from the annular space in which the diamonds are workings and to keep the latter cool. The core when formed passes into a core tube in which it is held, on the rods being withdrawn, by sliding wedges or clips. The diamond drill will cut through the hardest of rock, even emery having been pierced at the rate of 2 inches per minute. The ordinary rate of progress during actual boring is stated to be from 2 to 3 inches a minute in granite and the hardest limestone, 1 inch a minute in quartz, and 4 inches a minute in sandstone, and cores up to 20 feet in length have been extracted.

GEORGE DAYKIN.

EDITORIAL NOTES.

The results of the Gold Medal and other Competitions are given this issue. This has been a very successful scheme, and many of the students have done good work, especially is this the case with the winners of the prizes. It has been very satisfactory to us, as judges, to find that Messrs. Brown, Aitchison, and Wheatcroft, were so far ahead in the number of marks obtained, that there could be no possible debate as to their being really the prize winners. The work of classifying the students in order of merit has been much more difficult, but we think it has now been arranged as well as was possible under the circumstances. The number of candidates who entered the competition was over 120.

* * *

We have received a supplement to the first report of the Flameless Explosives Committee, and are pleased to see that the explosive Westfalit has been fully experimented upon; *ex parte* experiments are all very well, but one does not have full confidence in the results. The merits of this new explosive, however, can now be considered at their true value. It is stated in the report, an abridgment of which appears on another page, that the explosive, Westfalit, was obtained from the German manufacturers, we do not know whether the English syndicate of the explosive, Wesphalite, had been asked to supply their explosive, or whether they acknowledge the similarity of the two explosives, but in either case the results may be accepted as upon the explosive experimented upon in this country by the Westphalite syndicate, at least that is our opinion. With reference to the experiments throughout we consider them the most perfect and unrefutable of any yet made, but there are a few things to which we wish to again call attention, viz.:—(1) That the firing of a detonator alone in a coal gas mixture is sufficient to cause ignition. (2) That we cannot be assured that the small charges of explosive used in the experiments give results similar to what would be obtained from larger charges, such as are practically used in mines. (3) That in some instances the No. 6 detonators which were used throughout the explosive experiments were more than sufficient to give the explosive charge, notably in the case of ardeer powder, for which a No. 3 detonator containing little more than half of the fulminate of mecury contained in the No. 6 is deemed strong enough.

* * *

The Commissioners authorised by the Board of Trade to investigate the disastrous explosion which occurred two months ago at the Redcar Ironworks, and which caused the loss of 12 lives and severely injured many others, have decided to condemn the use of long unstayed externally-fired boilers, such as those which exploded. The owners of this type of boiler will now have to adopt one of three alternatives, the safest but most expensive of which will be to discard them altogether. The other two alternatives are to cut the boilers into two, or to have them fitted inside with longitudinal stays. The last method is however deemed insufficient and difficult, but the second method has been successfully adopted in many places previous to the explosion. It is seldom that so sweeping a condemnation is made, as these boilers can only be abolished or altered at an enormous cost. It is estimated that in the Middlesborough district alone upwards of a hundred are still at work, representing an original cost of £25,000.

REPORT OF THE FLAMELESS EXPLOSIVES COMMITTEE.

A SUPPLEMENT to their previous report containing results of experiments with Westfalit and a further series of experiments with detonators has now been published by Mr. A. C. Kayll, from which the following extracts have been taken:—

The explosive, Westfalit, has been brought prominently forward for use in mines in the same manner as other safety explosives since the issue of Part I of the Report of this Committee. The makers of Westfalit have erected an apparatus and have carried out a series of tests. The results of these tests are stated to be very similar to those carried out by other manufacturers when introducing

their safety explosives. Each explosive when introduced was stated by its manufacturer to be superior to those previously introduced.

The Westfalit used by the Committee was supplied in 3oz. cartridges, each of which bore the stamp of the manufacturer on the paper covers, and each 5lbs. packet was labelled "Made in Germany." Dr. Bedson and Mr. Saville Shaw analysed the explosive and it was found to consist of 95·55 parts of nitrate of ammonium and 4·55 parts of resin. The relative strength of Westfalit, ascertained by the Trauzl process, showed that 1½oz. was equal to 1oz. of bellite.

Westfalit, like other nitrate of ammonium explosives, exhibited many instances of incomplete detonation of the charge, as proved by part of the explosive remaining in the cannon after the shot had been fired. When a charge was incompletely detonated there was less flame resulting from the shot than when it was completely detonated.

Westfalit, when fired unconfined into air only, showed abundant evidence of flame and sparks. Several experiments were made under these conditions, and flames were observed varying in length from 18 feet to 27 feet, and quantities of bright sparks were seen generally. With stemmed shots no flame was observed.

The present series of experiments proved that Westfalit, when stemmed, ignited coal-gas mixtures, and failed to ignite pit-gas mixtures under similar conditions. When unstemmed, Westfalit caused the ignition of pit-gas mixtures.

Although there is only a difference of 34° Fahr. between the temperature of ignition of marsh-gas and oxygen and coal-gas and oxygen, not one of the seven explosives, when stemmed, has ignited an explosive mixture of marsh-gas and air, whilst on the other hand, all the seven explosives have readily caused ignitions of explosive mixtures of coal-gas and air.

Twenty-three experiments were made in pit-gas mixtures with twenty-five detonators, including Nos. 3, 6, and 8, which were fired at various points in the gas chamber. In one experiment three No. 6 detonators were placed at three different points and fired simultaneously. No ignition of the gaseous mixture was recorded in any of the twenty-three experiments. A summary of the several experiments shows that in coal-gas twenty-five experiments produced four or 16 per cent. of ignitions, and in pit-gas twenty-seven experiments caused two or 7½ per cent. of ignitions. It has been previously stated that it was somewhat remarkable that pit-gas mixtures were more readily ignited by detonators than coal-gas. The present results prove that pit-gas mixtures are not so readily ignited as coal-gas mixtures, and it is difficult to discover the cause of the two ignitions by detonators of pit-gas mixtures recorded in the report.

The conclusions deduced from the experiments are as follows:—(1) All the high explosives (ammonite, ardeer powder, bellite, carbonite, roburite, securite, and westfalit) are less liable than blasting powder to ignite inflammable mixtures of air and firedamp. These explosives, however, cannot be relied upon as ensuring absolute safety when used at places where inflammable mixtures of air and firedamp may be present. (2) The variable results following upon the detonation of high explosives appear to be due in some measure to defective admixture of, or variation in, the proportions of the ingredients used in the manufacture of the explosive. In view of the changes from time to time made in the proportions and constituents of high explosives it seems desirable that this information should be afforded by the manufactures to the users of the explosive. (3) In the storage of high explosives it is desirable that every care should be taken to ensure their being maintained in proper condition. It is also certain that these explosives alter in character with age. (4) It is essential that similar examinations of the working places and precautions which are in force in mines where blasting powder is used should be rigidly observed where a high explosive is employed. (5) In selecting a high explosive for use in a mine it should not be forgotten that the risk of explosion is only lessened and not abolished by its use. (6) All of the high explosives on detonation produce evident flame. (7) The possible ignition of an inflammable mixture of air and coal-gas by a blown-out shot of a detonated high explosive is not lessened by an increased quantity of stemming being used. (8) In the case of a charge of a nitro-glycerine explosive which has missed fire, if a short length of stemming (proved up to 8 inches) has been employed, the charge can be detonated by another cartridge of the explosive and additional stemming being placed in the hole in front of the original stemming.

DISTRIBUTION OF POWER IN COLLIERIES

THE following gives the general substance of a paper on the above subject by Mr. Llewellyn B. Atkinson, which was taken as read at a meeting of the S. Wales Institute of Engineers :—

To decrease the cost at collieries there are broadly three courses:—(1) To decrease the payment per ton to the mineral owner. (2) To decrease the wages cost per ton raised. (3) To decrease the fuel expenditure per ton raised. The first of these is a matter outside the scope of this paper, the second will be briefly touched upon, and the third will be dealt with in some detail. It appears to the author that what is required is to do in mining what has been done in every other department of industry, and to lower the cost of wages and material per ton by increasing the product per man and per pound of fuel by the following means: (1) Improved organisation both in the working and more especially in the original laying out of the scheme of working a colliery, and in the means for doing it; (2) more superintendence and supervision underground by thoroughly well-informed mining and mechanical engineers; (3) the greater use of mechanical power instead of human and horse labour, and more economical production of that power—in short, substitute brains and mechanical power for human labour.

A few remarks on the subject of mechanical power in collieries may be useful. The getting of coal resolves itself into cutting and filling, and hauling to the pit bottom. In the great majority of collieries, both cutting and filling are done without the use of mechanical power whatever, and the progress made in introducing mechanical coal-cutters is slow, at all events in this country. A considerable experience, extending over some years, with coal-cutting machines at various collieries in various parts of the country justifies the author in saying that there are hardly any seams under 3 feet 6 inches in thickness that could not be more cheaply worked by mechanical coal-cutters than by hand labour, with a better proportion of round coal, but that in all probability not 5 per cent. of the collieries in this country is the existing organisation of the filling and haulage sufficiently good to enable machines to be worked with that regularity which will make them pay. Organisation and superintendence, these are the only secrets of coal cutting by machinery.

Improvements in the general organisation may well be commenced by the economical laying out and conduct of the arrangements for the generation of power above ground.

All the engines are of an uneconomical type; so there ensues at every point waste of steam, particularly when, as in some cases, separate boilers are put down for each plant. It may fairly be said that there is a possible economy to be effected of 75 per cent. of fuel, worth annually nearly £900,000. This is based on the assumption that the coal used as fuel at the collieries is worth only 2s. 6d. per ton. It may be stated that to realise these economies the power required must be produced by triple expansion condensing engines—appliances almost unknown in colliery work; and to do this there is no doubt that the question resolves itself into the production of the whole power required at the colliery in *one* or at most *two* engines and its distribution with as little loss as possible to the points where power is required. There are various methods of distributing power, but some of them are only applicable to particular cases; the only two of general applicability are compressed air and electricity. With the one exception of the storage of compressed air the advantage in point of view of efficiency as a means of distributing power remains with electricity; and the economy of the cables compared with air-mains, the facility for extension and alterations to the position of the machinery, make electricity an ideal means of distributing power.

There is, however, an objection to which I must refer, viz., the question of safety. This question is one which has from the first been prominently before engineers, but it may be noted that among those who have had practical experience of its use in mines the objection is rarely raised. In the face of the facts and experience now at disposal in the author's opinion those who raise the objection ought to bring some proofs of the danger if it is to receive consideration. With regard to the possible economy spoken of early in the paper, it has been stated by Mr. Foster Brown that the probable consumption of coal in colliery engines would not on the average be less than 6lbs. per h.p. per hour. Tests are recorded where a consumption of 2·25lbs. per indicated h.p. were obtained, and reference has been made by Mr. D. B. Morrison to a plant using 1·72lb. per indicated h.p. The use of triple expansion instead of compound engines would further reduce this to 1·5lb. as originally stated.

The writer is aware that in thus advocating the generation of the whole of the power in one engine, or a pair of engines, he is advising a very radical departure from existing and well-tried methods, but the advantage in economy is so great that in his view a revision of method is well worthy of consideration and discussion.

Results of Gold Medal and other Competitions.

THE results of the above competitions are given below and we can only hope that those who have not been awarded prizes or certificates will be consoled by the fact that these are only given to those of exceptional merit. The persevering students have not, however, been forgotten. Under the circumstances, therefore, those students who have gained prizes or awards should esteem them the more highly, as the standard of merit was kept so high. The following are the results, the students being placed in order of merit. The names which have been bracketed are of equal merit and have been placed in alphabetical order:—

FIRST-CLASS.

GOLD MEDAL.

(1) Myles Brown, Butterknowle, Darlington.

CERTIFICATES OF MERIT.

(2) G. Daykin, 24, High Gurney Villa, near Bishop Auckland, Durham.
(3) Jas. Davies, 98, Picton Street, Maesteg, Glam., S. Wales.
(4) W. Slocombe, 11, Thorne Avenue, Newbridge, *via* Newport, Mon.
(5) S. Davies, Park Road View, Worsbro' Bridge, near Barnsley.
(6) J. Harrison, Ashington Colliery, Northumberland
(7) J. Jackson, 28, Ellesmere Street, Leigh, Lanc.
(8) J. McPhail, 6, Sourlie Irvine, Ayrshire.
(9) S. Thorpe, Chevet View, Ryhill, Wakefield.
(10) J. G. Bell, Evenwood, Bishop Auckland, Durham.

ADVANCED.

FIRST PRIZE.

(1) T. E. Aitchison, Green Hill, Dunaskin, Ayrshire.

CERTIFICATES OF MERIT.

(2) J. Crone, Chowden New Houses, Low Fell, Gateshead.
(3) J. Stephenson, Wharton Street, Coundon, Bishop Auckland, Durham.
(4) H. Hall, 15, Yardley Terrace, Ryhill, Wakefield.
(5) W. P. Laws, 28, Pilgrim Street, Murton Colliery, Sunderland.
(6) W. Sutherland, Granville Terrace, Liverpool Road, Hindley, near Wigan.
(7) J. Jones, Polydfryn, Aberderfyn, near Ruabon.
(8) T. Rimmer, 38, Clarence St., Newton-le-Willows.
(9) G. Bell, Shotton Colliery, *via* Castle Eden, Durham
(10) H. Talbot, Ince Green Lane, Ince, near Wigan.

ELEMENTARY.

FIRST PRIZE.

(1) J. Wheatcroft, 8, Longsight Terrace, Kinsley Hemsworth, near Wakefield.

CERTIFICATES OF MERIT.

(2) T. Webster, 7, Birchley Road, Billinge.
(3) J. H. Senior, 16, Thompson Row, High Street, Rawmarsh. Rotherham.
(4) F. Cherry, 143, Tudhoe Colliery, Spennymoor.
(5) J. Finch, Green Lane, Hindley Green, Wigan.
(6) Matthew Collinson, 341, Canny Hill, near Bishop Auckland, Durham.

The winner of the prize for the Advanced Stage may have an engraved silver medal, or H. W. Hughes' Text Book of Coal Mining, or books of equal value (18/-).

The prize for the Elementary Stage is Lupton's Mining, or books of equal value (9/-).

The certificates and prizes will be ready in course of a few weeks.

AWARDS

FOR ANSWERS TO COMPETITION QUESTIONS—No. 19.

ELEMENTARY—Jos. Wheatcroft, 8, Longsight Terrace, Kinsley Hemsworth, near Wakefield.
Commended—Thos. Webster, J. H. Senior, W. H. Hardy.

ADVANCED—T. Lawrenson, 21, New Boston, Haydock, Lancashire.
Commended—J. Stephenson, T. E. Shaw, H. Hall, T. E. Aitchison, J. Jones, J. Colley, J. Davies.

FIRST-CLASS—George Daykin, 24, High Gurney Villa, near Bishop Auckland.
Commended—Myles Brown, S. Davies.

COMPETITION QUESTIONS.

We make an uniform award of 2s. 6d. to the sender of the best answer to each of the questions given. Answers to be as brief as possible, and sketches must be made when necessary. One or both questions may be answered.

Envelopes to be marked "COMPETITION," and to reach us before August 23rd, 1895.

We invite readers to forward questions for this competition.

(1) A system of mechanical haulage is required in a level, 1800 yards long, to deliver 200 tons of coal in 10 hours to a pit eye, 400 yards below the surface. State generally what arrangements you would prefer for this work ?

(2) What errors in direction are likely to arise in surveys made with the magnetic needle and how can such errors be controlled and corrected ?

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o 20. Vol. III. SATURDAY, AUGUST 24, 1895. FORTNIGHTLY.
ONE PENNY.

CONTENTS.

EASY LESSONS ON

MINE VENTILATION.

By J. CARTER, First-Class Certificated Manager.

(COMMENCED IN NO. 9, VOL. III.)

SPLITTING OF AIR-CURRENTS.—Continued.

IF we have a number of splits of air in a mine passing an equal amount of air in each it becomes necessary that each of the shorter splits must be obstructed by a regulator to such an extent that their frictional resistances will be as great as that of the longest split when each have their due proportion of air passing through. If this were not done the shorter ones would pass too much air and the longer ones too little. We must note here that these obstructions lessen the total quantity of air in circulation. I have previously pointed out the advantage of having large airways, and will now point out the advantages gained by splitting the air in the following examples:—

EXAMPLE I.—Suppose we had a mine ventilated in one current, and before splitting we had 10,000 cubic feet of air per minute passing through the mine; area of air-course, 30 square feet (6 feet by 5 feet); rubbing surface, 25,000 square feet. What quantity will circulate when the current is split into 2, 3, 4, 5, 6, 7, 8, 9, or 10 equal parts, pressure remaining the same?

The relative quantities that will pass through airways subject to the same pressure will be found by the formulæ—

$$R = \sqrt{\frac{A^3}{S}} \quad \text{or} \quad \frac{\sqrt{A}}{\sqrt[3]{S}}$$

In this R = the relative volume, A = the sectional area of the airway, and S = the rubbing surface.

In the first case we have 10,000 cubic feet of air before splitting, find the quantity that would pass if divided into two equal divisions, pressure remaining the same. The above formulæ is applicable to this case.

We have 25 feet area and 25000 square feet of rubbing surface to begin with, when divided into two equal parts we have the same amount of rubbing surface but the area is doubled, viz., 50 square feet.

$$\therefore\ R = \sqrt{\frac{25^3}{25000}} : \sqrt{\frac{50^3}{25000}} :: 1 =$$

$$\sqrt{\frac{15625}{25000}} : \sqrt{\frac{125000}{25000}} :: 1 : 2{\cdot}8284$$

The above can still be simplified, because the rubbing surface and pressure remain the same in each case, so that the relative volumes obtained from splitting the air will be reduced to the following simple rule and be in proportion of $\sqrt{A^3}$

We will now proceed to find the relative quantities of air for the various splits, two three, and up to ten, equal division :—

For two splits $R = \sqrt{25^3} : \sqrt{50^3} :: 1 = 125 : 353 \cdot 55 :: 1 : 2 \cdot 8284$ relative volume.

For three splits the area will equal (25×3) 75 square feet $\therefore R = \sqrt{25^3} : \sqrt{75^3} :: 1 = 125 : 649 \cdot 518 :: 1 : 5 \cdot 19614$ relative volume.

For four splits the area will equal (25×4) 100 square feet $\therefore R = \sqrt{25^3} : \sqrt{100^3} :: 1 = 125 : 1000 :: 1 : 8$ relative volume.

For five splits the area will equal (25×5) 125 square feet $\therefore R = \sqrt{25^3} : \sqrt{125^3} :: 1 = 125 : 1397 \cdot 542 :: 1 : 11 \cdot 18033$ relative volume.

For six splits the area will equal (25×6) 150 square feet $\therefore R = \sqrt{25^3} : \sqrt{150^3} :: 1 = 125 : 1837 \cdot 117 :: 1 : 14 \cdot 6969$ relative volume.

For seven splits the area will equal (25×7) 175 square feet $\therefore R = \sqrt{25^3} : \sqrt{175^3} :: 1 = 125 : 2315 \cdot 032 :: 1 : 18 \cdot 52$ relative volume.

For eight splits the area will equal (25×8) 200 square feet $\therefore R = \sqrt{25^3} : \sqrt{200^3} :: 1 = 125 : 2828 \cdot 144 :: 1 : 22 \cdot 6251$ relative volume.

For nine splits the area will equal (25×9) 225 square feet $\therefore R = \sqrt{25^3} : \sqrt{225^3} :: 1 = 125 : 3375 :: 1 : 27$ relative volume.

For ten splits the area will equal (25×10) 250 square feet $\therefore R = \sqrt{25^3} : \sqrt{250^3} :: 1 = 125 : 3952 \cdot 859 :: 1 : 31 \cdot 62287$ relative volume.

In order to find the actual quantities from the relatives we must proportion them as below. If we had 10,000 cubic feet of air before splitting then the actual quantities would be as below :—

$$2 \text{ splits} = \frac{2 \cdot 8284 \times 10000}{1} = 28284 \text{ cu. ft.}$$

$$3 \text{ splits} = \frac{5 \cdot 19614 \times 10000}{1} = 51961 \cdot 4 \text{ cu. ft.}$$

$$4 \text{ splits} = \frac{8 \times 10000}{1} = 80000 \text{ cu. ft.}$$

$$5 \text{ splits} = \frac{11 \cdot 18033 \times 10000}{1} = 111803 \cdot 3 \text{ c. ft.}$$

$$6 \text{ splits} = \frac{14 \cdot 6969 \times 10000}{1} = 146969 \text{ cu. ft.}$$

$$7 \text{ splits} = \frac{18 \cdot 52 \times 10000}{1} = 185200 \text{ cu. ft.}$$

$$8 \text{ splits} = \frac{22 \cdot 6251 \times 10000}{1} = 226251 \text{ cu. ft.}$$

$$9 \text{ splits} = \frac{27 \times 10000}{1} = 270000 \text{ cu. ft.}$$

$$10 \text{ splits} = \frac{31 \cdot 62287 \times 10000}{1} = 316228 \cdot 7 \text{ c. ft.}$$

The following table will show more clearly at a glance the actual results :—

No. of Splits.	Relative Quantities.	Actual Quantities after splitting.	Actual Quantities in each Split.
2	2·8284	28284	14142
3	5·19614	51961·4	17320·5
4	8·	80000	20000
5	11·18033	111803·3	22360·6
6	14·6969	146969	24495
7	18·52	185200	26457
8	22·6251	226251	28281·375
9	27·	270000	30000
10	31·62287	316228·7	31622·87

We can obtain by Atkinson's formulæ (as previously shown) the same results, and it would be good practice for students to work out both methods and compare the results.

Example II.—Two airways of the same area and subjected to the same pressure are passing 120000 cubic feet of air per minute, the resistances of the airways are in the proportion of 6 to 1. What is the quantity that will pass through each. Rule—

$R = \sqrt{\frac{A^3}{S}}$ for one airway. $R = \sqrt{\frac{A^3}{S}} = 1$ that supposing A is 1, and S also is 1, so that for the second airway $A = 1$, while $S = 6$.

$\therefore R = \sqrt{\frac{1^3}{6}} = \cdot 40824$ Relative quantity.

The sum of the two relative quantities $= 1 + \cdot 40824 = 1 \cdot 40824$.

The actual quantities that will pass along each airway, whose total quantity is 120000, can be found by the following proportion :—

$$1 \cdot 40824 : \cdot 40824 :: 120000 : 34787$$
$$1 \cdot 40824 : 1 \cdot :: 120000 : 85213$$

Example III.—Suppose we had a mine which was ventilated by five splits (A, B, C, D, and E), the total quantity of air passing in the mine was 15000 cubic feet per minute, of this quantity A takes 4000, B 3700, C 3000, D 2300, E 2000. If we increased the ventilation from 15000 to 90000 cubic feet of air per minute, what quantity would pass in each split ?

The quantities would be in the following proportion :—

		cu. feet per min.
A's quantity	= 15000 : 90000 :: 4000 :	24000
B's "	= 15000 : 90000 :: 3700 :	22200
C's "	= 15000 : 90000 :: 3000 :	18000
D's "	= 15000 : 90000 :: 2300 :	13800
E's "	= 15000 : 90000 :: 2000 :	12000
	Total ...	90000

EXAMPLE IV.—If a current of 63480 cubic feet of air per minute was passing through a mine and was split into four airways as below, what amount of air would pass through each split? What pressure and what water-gauge would be required?

No. 1, 6 feet by 5 feet, 200 fathoms long.
No. 2, 6 feet by 6 feet, 150 fathoms long.
No. 3, 5 feet by 5 feet, 140 fathoms long.
No. 4, 5 feet by 4 feet, 120 fathoms long.

We must in this case find the relative volume of air that will pass in each split from the following formulæ:—

$$R = \sqrt{\frac{A^3}{S}}$$

A = Area
R = Relative volume
S = Rubbing surface

All the splits will be subject to one pressure.

Airway.		sq. ft.		sq. ft.
No. 1	Area =	30	Rubbing surface =	26400
,, 2	,,	36	,, ,,	21600
,, 3	,,	25	,, ,,	16800
,, 4	,,	20	,, ,,	12960

Relative volume, No. 1 = $\sqrt{\frac{30^3}{26400}} = 1{\cdot}0112$

Relative volume, No. 2 = $\sqrt{\frac{36^3}{21600}} = 1{\cdot}4697$

Relative volume, No. 3 = $\sqrt{\frac{25^3}{16800}} = {\cdot}9502$

Relative volume, No. 4 = $\sqrt{\frac{20^3}{12960}} = {\cdot}7856$

4·2167

To find the actual quantities we can proportion them as follows:—

Airway.		Cubic Feet.
No. 1	as 4·2167 : 1·0112 :: 63480 :	15223·03
No. 2	,, 4·2167 : 1·4697 :: 63480 :	22125·48
No. 3	,, 4·2167 : ·9502 :: 63480 :	14304·71
No. 4	,, 4·2167 : ·7856 :: 63480 :	11826·75
		63479·97

The slight difference is owing to not carrying the decimal points further.

To prove that the above is correct we can apply Atkinson's formulæ—

$$P = \frac{K S V^2}{A}$$

By doing so, you will find the value of P to be the same in each airway:—

$$\text{No. 1, } P = \frac{{\cdot}0217 \times 26400 \times {\cdot}5074^2}{30} = 4{\cdot}88 \text{ lbs.}$$

$$\text{No. 2, } P = \frac{{\cdot}0217 \times 21600 \times {\cdot}6146^2}{36} = 4{\cdot}88 \text{ lbs.}$$

$$\text{No. 3, } P = \frac{{\cdot}0217 \times 16800 \times {\cdot}5681^2}{25} = 4{\cdot}88 \text{ lbs.}$$

$$\text{No. 4, } P = \frac{{\cdot}0217 \times 12960 \times {\cdot}5913^2}{20} = 4{\cdot}88 \text{ lbs.}$$

$$\text{W.G.} = \frac{4{\cdot}88}{5{\cdot}2} = {\cdot}93$$

		lbs. Pres.	W.G.
Airway No. 1...	15223·03	4·88	·93
,, ,, 2...	22125·48	,,	,,
,, ,, 3...	14304·71	,,	,,
,, ,, 4...	11826·75	,,	,,

Although the quantity of air is different in each district, yet the water-gauge and pressure remain equal, which proves the correctness of the method.

(*To be continued.*)

COMPETITION QUESTIONS.

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Envelopes to be marked "COMPETITION," and to reach us before September 6th, 1895.

We invite readers to forward questions for this competition.

(1) It is required to determine the position of a distant point C in the workings of a colliery with reference to the surface, for this purpose a survey is made with the theodolite above and underground from the shaft A to C, and also to a second shaft B, by which means the underground and surface surveys are connected. State briefly (giving illustrated sketch of possible example if necessary) how you would carry out the survey so as to obtain the most accurate results. Give your idea as to the degree of accuracy obtainable by this method, and how far it would depend upon the relative positions of the points A, B, and C?

(2) State the nature of the dislocations of coal mines, their probable origin, their appearance vertically and on a horizontal plane, and the usual methods adopted for regaining the severed portions. Give horizontal and vertical illustrations of dislocation.

PRIZE ESSAY.

INDICATORS AND INDICATOR DIAGRAMS.

We offer a Prize of 10s. and a Special Certificate for the best Essay on "Indicators and Indicator Diagrams, submitted to us on or before September 12th. Articles to be illustrated and to cover about eight foolscap sheets, or less, ordinary writing.

Papers to be marked "Essay," and to be sent independent of any other matter.

ACCIDENTS IN MINES AND THEIR PREVENTION.

(Continued from No. 18.)

THE number of deaths resulting from falls of roof and sides during the past year was 444, or nearly 40% of the total number from all causes. The number of deaths from this cause in the previous year was 412, so that there is an increase of 32, which shows that there is no tendency of an appreciable reduction. There is evidently much room for improvement, but it is doubtful if any further legislative restrictions will reduce the percentage very materially, though "definite timbering" would, without doubt, be the means of saving many lives. Accidents from falls of roof are at once the most preventible and unpreventible of all mining accidents. This may sound enigmatical, but the statement is induced by prevailing incidents. When reading the account of an inquest occasioned by a fall the evidence in almost every case shows that the accident would not have happened had one or more props been set where they ought to have been, and in our own minds we think how easily this accident might have been prevented. Quite so, but what legislative or official enforcement or restrictions would be the means of preventing it? Would definite timbering prevent it? By no means. The workmen themselves have the remedy in their own hands, but they will not avail themselves of it. Between 80 and 90% of the accidents caused by falls are in the places over which the workmen themselves have charge, which shows how much the men are to blame. How often do we find that a fatal accident caused by a fall has been the result of gross carelessness on the part of the deceased? The whole of the blame must not be laid on the workmen however—the management are responsible for a great number of deaths from this cause. Especially is this the case with the shot-lighter, who is supposed to examine the locality in which a shot has been fired before allowing the workmen to resume work. His examination in many cases only occupies a few seconds, and any slips which have been made perceptible by the shot remain unseen or disregarded. The manager is the principal cause of this remissness rather than the shot-lighter, as the work which the man has to attend to does not allow him sufficient time to do his work properly.

The following are the writer's suggestions for reducing the accidents from falls:—

(1) Legislative enforcement of definite timbering.

It is doubtful whether it would be wise to fix any definite maximum distance for all mines similar to that for spragging the coal, as the nature of the roof and general conditions are so widely different. It would probably be better to compel the manager to fix a definite distance for each mine under his charge, and if this distance was deemed insufficient by the inspector visiting, he should request the manager to reduce the distance. The manager to have the option of referring the matter to an arbitration committee if he deemed the definite distance already fixed by himself as sufficient for the proper guarding of the workmen. If a definite distance was fixed for all mines it would be necessarily great to suit the most extreme cases of mines with good roofs, and managers would not be inclined to reduce the distance for their own special cases, as they would feel that no further responsibility rested upon them in the matter.

(2) The work of the deputies, firemen or shot-lighters should be reduced, so that they would have ample time for the firing of shots and the examination of the working places.

It would be a very difficult matter, if not altogether an impossibility, to effect this latter by legislation, as the daily work of a fireman or shot-lighter could not be definitely fixed, but some alteration is necessary. The examination in many cases is a "farce," for the simple reason that it takes the fireman—especially the night-fireman—all his available time to rush round the workings, let alone examining them.

Several of H.M. Inspectors of Mines have dealt in a very practical manner with the subject of accidents caused by falls, as the following extracts from the annual reports for the past year show:—

From Mr. Hy. Hall's Report.—"There can be no doubt that this class of accident can by stricter and more definite rules be made less frequent. The rule unanimously recommended by the inspectors for adoption throughout the kingdom and to be enforced by legislation is in the following words:—Every certificated manager of a mine shall specify the maximum distance 'that props or supports may be fixed in every coal seam under his charge.' The reasons for this

change have been set forth again and again, and may be summed up in the statement that under the present law the responsibility for the security of the roof in the working places is cast entirely upon the workman himself. Whether he is capable or inexperienced, careful or careless, he has to be the judge to a very large extent of what supports should be put up to keep the roof from falling on him, and whilst this is so it is very difficult to convict him of carelessness. There can be no question that the definite rule requiring sprags to be set at fixed distances, whilst undercutting coal, has saved many lives, and a similar *definite* rule is wanted with regard to the roof, so that when an official visits a workman's place and finds the rule being neglected he can act with authority. As things are at present the official's interference either takes the form of an acrimonious argument with the workman as to whether certain supports *are needed or not*, or he contents himself with amiably suggesting to the workman that he must take care of himself, and leaves him to do it as best he can."

From Mr. WARDELL's Report.—"Many of the accidents which arise from falls are very difficult to be prevented even by the strictest surveillance. The management must see that timber is available on the spot, and where and when it is required; but the workman himself should look after the roof and sides of his own working place, over which he has entire control, subject of course to the regulations of the colliery, and being constantly engaged there he must know what is required as his work proceeds. The personal care by the workman and the responsibility of the owner and manager should not on any account be weakened. Some accidents arise from want of ordinary care. In spite of warning, a workman will sometimes expose himself to danger rather than be at the trouble to use material which is close at hand in order to make himself secure. In other cases falls occur by reason of 'slips' or 'partings' which cannot by any possibility be detected beforehand. It is always better, as I have said before, to set more props than appear to be required than one too little. The regular setting of timber at stated intervals if enforced by law would only be extending what is already enacted by special rule in this district with regard to sprags. I also repeat what I have always advocated, that a regular system of inspection of working places should be carried out during the time the men are at work as well as before they commence."

From Mr. GERRARD's Report.—"In nine cases props were either being taken or the fall followed immediately after. In one case a fireman knocked out six props, one after the other, in great haste, never paused or listened a second, the evidence was perfectly clear. Some of the accidents have followed very shortly after the visit of the fireman—this official in some cases having fallen far short of what one would like to see in regard to careful examination of the place, the discovery of indications of weakness in the roof, followed by insisting upon the collier coming himself to the spot and seeing that a full view of the danger was recognised by the collier. Holding these views how can I think otherwise than many, if not most of the accidents from falls of roof and sides are preventible. I am bound to say that the uniformity of timbering whilst it would prevent many would not provide for all. Some of the falls have occurred where such uniformity has been established by direction of the manager. Often do I feel gratified to the coroner who permits a little latitude in the examination of a witness at an inquest and enables one to show the true circumstances attending the unfortunate fatality; when the coroner has satisfied himself as to criminal negligence, or accidental death, by a few plain questions, bringing home to the witness, often a surviving companion, how by a little care the accident might have been avoided. In these cases "*de mortuis nil nisi bonum*" does not apply. It was after attending one of these inquests where, owing to a more than ordinary intelligent witness, and a fair one, it was clearly shown that the 'slips' to which the fall was due ought to have been seen and provided for. Walking with the police constable he told me that he had worked as a hewer in Northumberland, that it was the practice in those days to mark in the coal the position of any back or slip revealed in hewing. I had not before heard of it. Unquestionably such a practice increases the observing power of the worker, records what has so often not been noticed, or, if so, forgotten. Many slips continue from the coal into the roof, it must needs be so from their cause, from their formation."

Accidents in shafts have been responsible for 77 deaths during the past year, or nearly 6 % of the total deaths. The number of deaths under this head has been decreased to a greater extent than has any other as will be seen from the percentage. The

average percentage of accidents in shafts since 1851 is over 13, while that of the present year is less than 6, a very remarkable decrease. This is accounted for by the fact that the accidents are almost all preventable and simply require good appliances. To take the sub-division of overwinding as an example, only one death has been caused during the last two years, which is the result of the universal use of that very effective appliance the "detaching hook." Several appliances have been introduced to cut off the steam and stop the engine when winding too quick near the surface, thus preventing the overwind, but although the actual prevention of the overwind appears to be the better course, these appliances have not found much favour, partly because the arrangement is complicated and too delicate, and partly because the detaching hook—a much simpler appliance—is so effective. For the further prevention of accidents from overwinding the writer would recommend a very simple addition to the detaching hook, and one that is in use at many collieries, viz., the fixing of stops* in the head-gear, above the height to which the cage usually ascends, which will allow the cage to pass up but prevent it from falling back again. These are not only convenient for reattaching the cage to the rope after the overwind, but should the shock break the suspending beam or the chains, or if the detaching hook fails to support the load—an occurrence which has actually occurred—the stops will prevent the cage from falling down the shaft.

Accidents caused by chains and ropes breaking in shafts have also been reduced to a minimum. There were only two deaths caused by a rope breaking, and as this rope was only used in an emergency, the accident is an excusable one. There is no reason why ropes or chains employed for winding men should break if ordinary care is used. Thirteen men were killed last year and 28 the previous year whilst ascending and descending by machinery. The majority of these occur in sinking shafts, and in the writer's opinion are almost all preventable. A large number occur through the oscillation of the hoppit in winding, all of which could have been prevented by the use of guides. The efficiency of guides in sinking shafts has been sufficiently proved during recent years to recommend their general adoption apart from the increased safety accruing thereby. The deaths caused by falls down the shaft from the surface, numbered 3 for 1894 and 6 the previous year. There is absolutely no reason why any of these should occur, and it is again a question of imperfect appliances. Why any man in his sound senses should prefer the use of sliding doors, or doors opening on hinges, or single cross-bars of iron to the automatic lifting fence for preventing falls from the surface of a winding shaft is more than the writer can grasp. Not only does the lifting fence render the banking safer, but it also facilitates the work, while the increased cost is a mere trifle and cannot be taken into account. Four deaths were also caused by things falling from surface; automatic fences would in all probability have saved some of these. Falls from part way down the shaft are responsible for the largest number of deaths in shafts, during the last year the number of deaths being no fewer than 22, which is an increase of 4 on the deaths of the previous year. In almost every instance these deaths are caused by falls from an intermediate mouthing in the shaft. During the past year a special rule has been made throughout the whole of Scotland districts with a view to minimising these accidents to the effect that the fence at an intermediate hanging or mouthing must be connected to an indicator in the engine-house, so that the engineman will not start the engine before the fence has been shut. Two deaths have been caused during the last year by things falling from part way down the shaft. These can only be prevented by complete walling of the shafts from top to bottom, for no matter how strong and secure the rock may be a piece may slip out at any moment.

Thirty deaths are recorded as miscellaneous in shafts, many of which have been occasioned by men passing across the shaft to get to the opposite mouthing. All shafts with two mouthings on the same level should have a separate road round, so that to cross from one mouthing to another it will not be necessary to pass under the travel of the cages or through the cages. The following are the principal precautions the writer advocates for the prevention of accidents in shafts:—

(1) Detaching hooks to be provided to all shafts in which men are wound by machinery.

(2) Guides to be provided in sinking shafts which exceed — yards in depth, and if there is not — feet clearance between the hoppit and the shaft walling or — feet clearance between the hoppit and any buntons or other obstructions, guides to be used in sinking shafts which exceed — yards in depth.

* To be described and illustrated in the article on Colliery Engineering in next issue.—Ed.

(3) Automatic lifting-gate fences to be provided to all working shafts.

(4) The fence gates at all intermediate hanging-on mouthings to be connected to an indicator fixed in the engine-house.

(5) All new shafts to be walled throughout.

(6) A travelling road to be provided—not exceeding 20 yards in length—between one mouthing and the one opposite (if any), unless there is sufficient space to pass round the travel of the cages.

(To be continued.)

THE ADVANTAGES OF IRON OR STEEL GIRDERS FOR SUPPORTING THE ROOF IN MINES.

By S. DAVIES.

THERE are various systems or modes of securing the wide portions of the main roads underground, about the pit bottom, junctions, pass-byes, engine-houses, and landing-stations. These places are very important and at all times need minute and proper attention to the general nature of the roof and the quality and strength of the material intended to be used. In the next place great care should be exercised in cutting out the ground and setting the material, which is an important factor to maintain, protect, and secure wide roads against falls of roof, etc., and especially so in order to secure wide roads in soft or bad ground, and, indeed, in all permanent wide roadways, even where the roof is tender and of a soft nature and the sides firm, solid, and strong. Therefore, preference is given to steel girders under such circumstances, because they make a capital substitute for wooden bars, or as they are generally called, "baulks." The use of steel girders has several advantages over roofing timber of all kinds, although the first cost may be relatively high as compared with timber, yet the advantages upon their employment more than recoups the first and additional outlay.

Their advantages are as follows:—

1.—Steel girders will carry or bear greater strain than timber bars, because steel is exceedingly tenacious. It possesses the extraordinary tenacity of from 30 to 50 tons per square inch of section, while the best and strongest wood has only the tenacity of from 3 to 10 tons per square inch of section; steel has also a greater elasticity than timber.

2.—Steel girders possess a longer life, some stand good from four to six years without showing the least signs of displacement whatever, while timber bars begin to bend in a few months' time, which causes the height of roadway to be reduced to such an extent as to cause considerable inconvenience, if not sufficient to stop the traffic altogether, in order to replace the bent or broken bar and to re-secure the road, thus causing a large amount of labour, expense, and, more than all, reducing the output of coal for that day.

3.—Steel girders take less labour, time, and room for excavation and they do not reduce the height of the roads so much as large thick timber.

4.—They can be raised and set into their required position and handled by a less number of men. Three workmen can handle any kind and length of girder, 12 inches by 10 inches and from 16 feet to 18 feet in length, while it would take four men to handle and raise a bar of timber of the same size and length.

5.—The steel is not corroded by the atmosphere of the mine, while the timber underground is greatly affected by the warm, damp atmosphere, which promotes the growth of the cotton mould fungus. When the timber dries and cracks, the germs of the fungus enter the wood and decay at once begins.

6.—Again, when the roof settles down on the girders, instead of breaking down through the middle, as is often the case with timber, the girders only bend, and by taking them down and turning them the other way up, the girder becomes as strong, if not indeed stronger than before, since it will be formed into a natural arch.

7.—The girders will support a greater area of roof than timber, they are less expansive, and after being used in the mine for a long period, they can be sold as old scrap.

8.—They make the roads safer and stronger, afford better protection for the transit of mineral, and for the workmen to pass along such roads at all times. We have a very large number of such steel girders at our colliery, set in position along the various main roads. They are so light, safe, strong, cheap, and expeditious, and so exceedingly satisfactory in all the roads in the mines, that I have no hesitation in saying there application is highly satisfactory.

THE ENGINEERING OF COLLIERIES

Being a Treatise on Colliery Machinery, Appliances, and Constructions.

By T. A. O'DONAHUE.

(COMMENCED IN No. 9, VOL. III.)

WINDING (continued).

KOEPE SYSTEM.—By this system of winding the drum is entirely discarded and an ordinary single-grooved pulley substituted. Only one winding rope is employed, and this passes from one cage half round the pulley and back again to the other cage. As the tail rope is used in conjunction, the whole may be likened to an endless rope. The advantages of such a system are that a light and easily moved pulley is substituted for a heavy drum, thus reducing the initial load on the engines and rendering smaller engines permissible. The engines may be placed nearer together, and thus derive the accruing advantages of smaller engine-house, shorter crank shaft, &c. Angling of the rope between the winding pulley and the headgear pulleys may be prevented by inclining the latter towards each other instead of fixing them parallel, and the winding rope will last twice as long. The disadvantages of this system are, that if the winding rope broke both cages would be precipitated to the bottom of the shaft; there is a difficulty in recapping the rope, as there is no available excess rope to make use of; and the rope is apt to slip round the winding pulley, especially does this occur when the cages are resting on the keps altogether, though there is another method of overcoming this difficulty. When the cage is on the keps the weight of the tail and winding rope may still be made to bear on the motive pulley by connecting the tail rope to the winding rope by means of crossheads placed above and below the cage. There are also several methods of providing against the contingency of both cages falling if the winding rope broke. On the continent an automatic brake has been placed on the pulley, which in case of the rope breaking presses on the pulley sufficiently to prevent the rope from slipping. Another arrangement which the writer thinks was the one adopted at Bestwood Colliery, Nottingham, where the Koepe system was first applied in this country, is to have in addition to the ordinary winding rope a lighter or auxiliary rope, which passes over two pulleys fixed at right angles to the winding pulleys in the headgear. The auxiliary rope is connected to each cage, and so long as the winding rope supports the cages it simply works over the pulleys, but should the weight of the load have to be supported by it, the rope tightens on the pulleys and brings the cages to a standstill. When this precautionary rope is applied it is necessary to have the tail rope sufficiently heavy to counter-balance both the winding rope and the auxiliary rope.

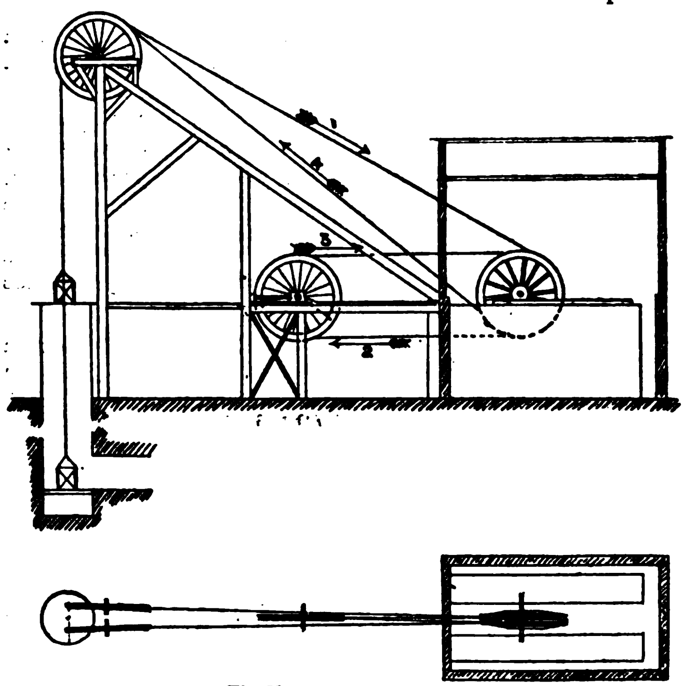


Fig. 36.

CRAVEN'S METHOD (fig. 35).—This method is somewhat similar to the Koepe, but it possesses the advantage of being able to recap the rope, and there is not the same danger of both cages falling to the bottom of the shaft if the winding rope breaks. Only one rope is employed, but the motive power is applied to a set of pulleys connected together, instead of one as in the Koepe system. An intermediate pulley is also provided between the engine-house and the headgear. The direction of the rope is shown

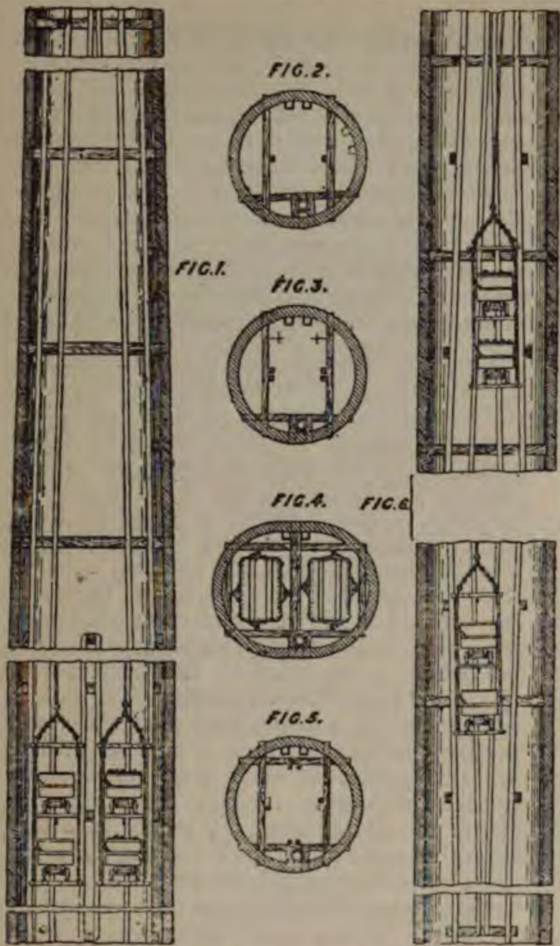
by the numbered arrows. It will be seen that it passes from one cage over one of the head-gear pulleys to the motive pulleys, from thence to the intermediate pulley back again to the motive pulleys and over the headgear pulley to the second cage. The bearings of the intermediate are placed on a sliding frame so that it may be adjusted to the rope; when the rope has to be recapped the intermediate pulley is moved nearer the engine-house. To prevent angling the head-gear pulleys are inclined towards each other as in the Koepe system.

Neither the Koepe system or Craven's winding gear have as yet received much favour in this country.

Pass-bye for Cages in Shaft.—An arrangement of a pass-bye for the cages in a shaft, enables winding to be performed in a much smaller shaft than would otherwise be required. At many collieries it has been the practice where rigid guides are in use in the shaft to belly the centre of the shaft out slightly for the passage of the cages, but it was not until quite recently that an attempt was made to run two cages in a shaft which was originally only intended for one of the same size. The adoption of such a course is however now in course of construction at Llay Hall Colliery, Cefn-y-bedd, near Wrexham. The manner in which this is being done was described by Mr. W. H. Wilson, M.E., at a recent meeting of the North Wales branch of the National Association of Colliery Managers. The accompanying sketches are those given by Mr. Wilson, and the following is an abbreviated account of the arrangement:—The system of pass-bye is applicable only to a shaft with rigid guides, and in this particular instance is a shaft of 9 feet diameter and 270 yards in depth. The pass-bye from its commencement to its finish covers a vertical length of 100 yards, and is sub-divided into the following sections, viz.:—8 yards, 35 yards, 14 yards, 35 yards and 8 yards; the 2nd and 6th measurements are inclined inwards and outwards from and to the centre 14 yards, the other measurements being vertical. The cages are 5 feet by 2 feet 7½ inches over all, and are double-decked single tub cages (the same can be made to suit either single, double, or treble-decked), with one tub on each deck, and taking a tub of the following dimensions:—20 inch gauge, 2 feet 3 inch wide, 2 feet deep, and 4 feet 2 inch long, being 4 feet 6 inch over the buffers; each cage has eight cast-iron shoes fixed on—that is four shoes on each square of the cage, those on the ends of the cage are half-shoes only, well bracketed, bolted on the angle iron of the cage with bolts with counter-sunk heads, and have lock-nuts with cotters through same; the four shoes on the sides of the cages are the ordinary shoes which run on wooden guides in any shaft; the cages are steel throughout and are of the most approved and latest design, and are in every way made suitable to work on this system of guiding.

Commencing from the top of the shaft in a downward direction the bearers are placed in the centre of the shaft—that is, equidistant from each side of the shaft, the same being 4 feet 5½ inches between them, and are 9 inches × 5 inches pitch-pine. They have wood brackets, 1 feet 6 inches × 9 inches × 4½ inches, bolted on them, and with their edges in a longitudinal direction rounded 2 inches from the square of their length and thickness respectively at each end; on these are bolted the guides with slightly-rounded edges, and are bolted to the brackets and bearers with T-headed ¾ inch diameter bolts. The guides are 5 inches × 4 inches hard pitch-pine, and project 5 inches way into the shaft. There are two guides to each cage immediately opposite each other, the same being 7 inches centre to centre, being 3½ inches each way from the centre of the shaft, and thus allowing 3 inches clear space between each, so that each cage has its own guides and only travels on those. If you stand facing the pit head on its front the right and left hand guides in each case run right through, from top to bottom of shaft—that is, the two guides diagonally opposite to each other, the other two guides diagonally opposite the whole (being four in number)—to a point 8 yards below the commencement of the pass-bye, and there finish, the terminal of each being a cast-iron block of the same section as the guides and bolted on to the bearers 5 inches long and 4 inches wide, and tapered each way to an apex; these same two guides commence again in the same centre line of each other 8 yards from the finish of the pass-bye, and commence with a cast-iron block and run from thence to the bottom of the shaft.

Fig. 1 is a vertical section, showing position of cages loaded and empty at the centre of pass-bye; the shaft at this point being oval in shape. Fig. 2 is a horizontal section of shaft indicating altered positions



of rope boxes, shown in full lines in lieu of those in dotted lines. Fig. 3 is a horizontal section of shaft at top and bottom, showing position of main guides, and also centres of winding ropes at the top of pit, and on the winding pulleys. Fig. 4 is a horizontal section at centre of pass-bye, showing oval shaft 11 feet 4 inches by 9 feet. Fig. 5 is a horizontal section of shaft, showing extreme ends of pass-bye both top and bottom. Fig. 6 is a vertical section of shaft, showing relative positions of loaded and empty cages after having passed each other.

(To be continued.)

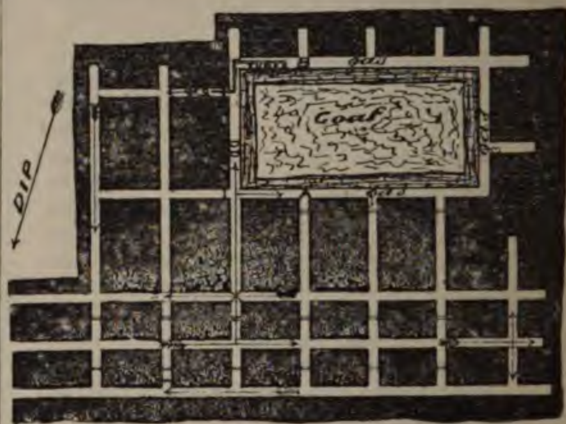
NOTICE TO READERS.—Owing to a change being made in the publishing of our Journal, commencing with next issue, we should be obliged if they will notify us at once of any delay or their inability to obtain the Journal from their Agents in future.

ANSWERS TO COMPETITION QUESTIONS

IN NO. 17, VOL. III.

THE REMOVING OF ACCUMULATIONS OF GAS.

(1) If you suddenly found you had a higher side goaf filled with firedamp, the goaf being 50 yards up and 100 yards wide, with a drawing road on each side, describe the course you would take to remove the gas, assuming you had sufficient air.

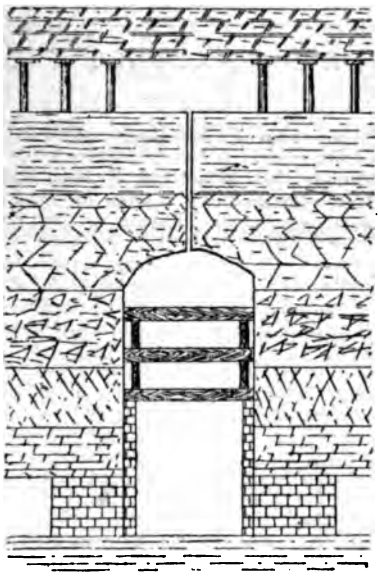


Answer.—(1st.) In compliance with the requirements of Gen. Rule 7, C.M.R.A., I would take immediate steps to bring the men out of this part. (2nd.) Rearrange and repair all the stoppings and air-crossings (if any). In the meantime prepare a line of air-pipes (sheet-iron tubes preferred) and fix them in the upper or top side drawing road, as near to the roof as possible. The outer end pass through into the return, and the other end carry on as near as convenient and safe to the nearest point where the gas is issuing out of the goaf. The tube-pipes will answer for a return, and the fresh air-current will course along the low side-road. Firedamp being little more than half the weight of air floats or stratifies at the upper parts nearest to the roof. No amount of practical dodging can alter this law of nature, therefore, the tubes must necessarily constitute the return and also have the shortest cut and direct connection with the main return airway. By this arrangement only can the gas be removed successfully. (3rd.) The gas to be removed when the workmen are out of the pit. By coursing the fresh air-current in the above manner nothing can enter the orifice of the tubes but gas, and while the gas is being removed the fresh air will ascend or

rise more freely into the workings, causing the dreadful enemy to disappear; the workmen can then recommence work without any danger in a life-supporting atmosphere. If there were any doors on the lower drawing road they would have to be kept open until the gas was removed satisfactorily. In some cases stoppings can be broken through so as to remove such accumulations of gas and then repaired again, but along a line of goaf it is not an easy matter to remove such. Practice and theory must go hand in hand (see sketch). SAMUEL DAVIES.

DRIVING STAPLE PITS UPWARDS.

(2) Describe how you would drive and secure a staple pit, 10 feet diameter, upwards from one mine to a mine 20 yards above.



Answer.—I suppose that these two seams are being worked, and it is found necessary that a staple should be driven to connect these seams for the purpose of either ventilation, economy of haulage, etc. At the colliery where I am engaged there have been staples driven from time to time to make a connection between the main coal seam and the five-quarter, which is 28 yards apart, therefore I will just describe from facts how they have been driven—one especially. In the first place the plans have to be examined and the best position chosen, then a survey must be taken, and exactly where the centre of the staple should be a 3-inch borehole should be put up from one seam to the other. In one case this proved to be of excellent service in ventilating the staple whilst being driven, as any gases from the strata or from the explosives, lamps, etc., which were given off naturally rose up through this borehole and escaped into the return; this borehole also proves to be a good guide for the workmen. The next thing was to strongly support the bottom of the staple by strong arches of masonry for a distance along the roadways, as seen on the sketch. A strong wall was then built a few yards up the shaft, and upon this rested four strong baulks, these being prepared on the surface, and are made to fit one within the other. On these baulks the scaffolding is securely fixed, and whenever the staple is a reasonable distance punch props are placed on the last frame of baulks. These props support another set of four strong baulks in a frame (see figure), and are built up every three or four feet, according to the nature of the strata. It is necessary that some arrangements should be made to protect the workmen as they are returning up to their work after firing a shot from any stone which may be hanging loose. This is accomplished by building the scaffolding off and on, that is, the scaffolding is placed halfway along the right side of the first baulks and on the next it is placed halfway along the left side of the baulks, and so on, thus acting as a ladder for the men to reach their work. It is also necessary when a staple has to be driven that men of experience should be chosen and to have a chargeman in each shift, who shall fire all shots and be the first to return after firing to examine and determine the result; all shots to be fired with electricity. It will be noticed that I have treated the staple as if it had to be driven 10 feet square. The reason why I have done this is, because most staples are driven either square or rectangular in shape. They are easier to drive and secure, and they may be divided into compartments, one for a ladderway for the workmen and the other for the cages. GEORGE DAYKIN.

AWARDS

FOR ANSWERS TO COMPETITION QUESTIONS.

Question 1.—Sam. Davies, Park Road View, Worsbro' Bridge, near Barnsley.

Question 2.—George Daykin, 24, High Gurney Villa, near Bishop Auckland, Durham.

Commended.—J. Davies, T. Rimmer, J. Harrison, J. Daniels, J. Hardman, H. Hall, J. Crone, A. Elce, G. Bradley.

EDITORIAL NOTES.

Apropos of the Gold Medal and Certificate Awards to the Competition Questions, the Prizes and Certificates will be sent out next week. It will be noticed that we offer a prize in this issue for the best Essay on Indicators and Indicator Diagrams.

* * *

At a students' meeting of the Federated Institute of Mining Engineers, held last week at Newcastle, Mr. Austin Kirkup read a prize essay on "The Prevention of Accidents in Mines." The chief points to which the writer referred to were, adequate ventilation, thorough inspection to guard against accumulations of gas in old workings (stopping off such as cannot be ventilated), the employment of delicate gas-testers, the compulsory use of sprags, the necessity of good light for examining the roof and sides, compulsory application of electricity for shot-firing, and to the advisability of using sluice valves when boring against high pressures of water.

* * *

At a recent meeting of the Midland Institute of Mining Engineers, Mr. R. Kennedy read a paper on "Electrical Machinery for Mines," and M. G. B. Walker described Dr. Roth's (inventor of roburite) system of shot-firing. By this method chlorine gas, generated in a suitable vessel, was allowed to pass through a tube inserted in the stemming of the shot-hole to a detonator charged with metallic antimony and fulminate of mercury. The chlorine reaching the detonator combined with the antimony, produced heat which exploded the fulminate of mercury, and the explosion being produced entirely by chemical combustion no spark was produced. It was claimed that the method was a cheap one as compared with electric detonators, but whether this was so or not, and whether the necessary conditions could be carried out in practice by ordinary workmen would have to be tried, but the method was undoubtedly an ingenious one. Mr. Walker was endeavouring to obtain a set of apparatus, and would be pleased to lay the results of the experiments before the Institute.

* * *

A question now affecting the English coal trade is the solicitation to the French ministry by an influential party to accept a reduced tariff for the carriage of coals from the French pits to the western portion of France. This would benefit the French, Belgian, and German collieries, but would diminish, if not in time render totally extinct the English export trade of coal to the north and west of France. The importance which this question bears to the English industry may be realised when it is understood that over four million tons of coal are annually exported to France.

The proposal of the Lancashire Miners' Association for the formation of a conciliation board to deal with all local disputes having been forwarded to the Coal Owners' Association, Mr. T. R. Ellis, the owners' secretary, has replied that in their opinion sufficient machinery exists for dealing with disputes, and it is therefore unnecessary to reopen negotiations with a view to forming a special board of conciliation. A similar answer was made last year.

* * *

The proceedings of the Birmingham meeting of the Iron and Steel Institute commenced on Tuesday last, under the presidency of Sir David Dale. The first paper submitted was by Mr. Daniel Jones, secretary of the South Staffordshire Ironmasters' Association, in which he gave a sketch of the iron industry of the district, and the changes that had come over it of recent years. He was followed by Mr. W. H. Hughes on mineral resources of the district, by Mr. E Bonehill on direct puddling of iron, and Mr. G. Kamensky on the iron industry of South Russia.

ANSWERS TO CORRESPONDENTS.

John Nichol.—We are always pleased to receive suggestions, especially from old readers like yourself; they shall be duly considered, we have handed your letter to the proprietors. Thanks for questions sent, you will see we have used some of them; we do not purpose publishing the others as they are chiefly metal mining, which is generally beyond the scope of our small paper.

Re Colliery Managers' Exams.—We have expressed our opinion in this matter. Personally we consider it right to withhold exam. questions; as a candidate is given a general outline of what he is expected to know, he should be prepared for any fair question on colliery work. The questions are given to test a candidates' capabilities of colliery management, and not because a similar one was given at previous examination. We can, however, see no reason for the non-publication of the names of successful candidates.

Intended Contributor.—We pay at least a fair price for accepted articles according to merit. Fulsome praise in lieu is worse than no payment, as it only brings the writer under the reader's contempt and satire, and prejudice causes his articles to be underrated.

G. F.—The first-class competition was open to all, and it was impossible to give a different decision. We hope all are satisfied.

J. H. Sherwin, Ignorant, T. H. Pearson.—Will try and insert next issue.

Literary communications to be addressed to the Editor, "Mining," Clarence Yard. Wallgate, Wigan.

Readers will please notice that we have made arrangements with Messrs. W. H. Smith and Son, to supply our Journal at all their bookstalls on order.

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MINING

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No. 21. Vol. III. SATURDAY, SEPTEMBER 7, 1895. FORTNIGHTLY. ONE PENNY.

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THE LAW RELATING TO

MINES, MINERALS, & WORKERS.

By T. F. UTTLEY, F.I.I., Manchester,
Author of "Factory Inspection;" Editor of "Labour Contracts," &c., &c.

(Specially written for this Journal.)

I.—OWNERSHIP OF MINERALS.

IT frequently happens that the ownership of the surface of land is vested in one person and the minerals in someone else, and there may be several distinct rights and ownership to different minerals under the same surface and even of qualified interests to minerals both when distinct and blended with the ownership of the soil. The crown has a claim in respect of mines of gold and silver, and to minerals under the high seas, except where alluvion, and it can claim minerals under the sea shore unless the lord of the manor or owner of adjoining freehold establishes a prescriptive title to them. Where the ownership of the minerals is severed from that of the surface, the owner of the surface requires a good claim to be made before the minerals can be worked, and written evidence should be given of some proofs of acts of ownership and length of possession, and the claimant of the minerals cannot rely on mere reputation of owernship as against the owner of the surface, but he must show uniform usage and exercise of the right. Though prescription may give the right to work minerals, yet that does not necessarily confer the right of property in the minerals themselves as they are part of the land itself.

If the right to the minerals belongs to a person who is not the surface holder, and there has been no possession or establishment of title by any one else by acts of ownership, the right of possession remains in the original owner, and, therefore, no presumption of waiver or grant arises from the non-user of the right in favour of the owner of the surface. Minerals are frequently reserved and remain unworked for years in order that when other mines are won the reserved mines may be utilised.

The mere absence of the exercise of rights of possession by the actual owner of mines is not affected by the statute of limitations which deals with the adverse possession of others.

In the case of copyhold lands, though the property in the minerals is owned by the lord, yet the tenant has a possessory interest, and one cannot explore without the other in the absence of prescription or custom, and, therefore, only mines and quarries already opened can be worked. By prescription or custom the lord of the manor may have a right to take the minerals against the copyholder or the copyholder against the lord, but the custom must be a reasonable one.

The severance of minerals from the inheritance gives the lord a right to recover them even though the severance is carried out by the copyhold tenant or any one else. When a custom is established which shows when a lord may work the mines it will be assumed that the reservation of the minerals is in him.

With regard to the enfranchisement of copyholds statutory provision has been made in some cases for the compulsory commutation of certain rights of the lord and in others for the voluntary enfranchisement of such lands. If it is expressly agreed upon between the lord and tenants, but not otherwise, the commutation to be made in respect of the rents, fines and heriots thereafter to become due in respect of manors may be extended to mines and minerals. No commutation was to affect any rights of lords of manors to any mines, minerals or quarries, or other manorial rights unless expressly commuted. In aid of the reservation of the lords rights in mines and minerals, the tenants upon any commutation or enfranchisement might grant rights of way and easements to the lord to win and carry away the mines and minerals under the tenants lands.

Various statutory enactments provide for the securing and settling of mineral rights; written consent must be obtained to any enfranchisement dealing with the mineral rights of the lords of manors or tenants.

As a rule the lord of the manor has a claim on all waste land in his manor, and the exclusive property in the soil of all common and waste lands of the manor and rights of property in the minerals is in him, but custom may deprive the lord of the manor of the minerals.

With regard to the right to the minerals of a common, these can be either (*a*) in the lord by presumption of law, or (*b*) in the commoners by prescription, based on custom or on acts of ownership; or (*c*) in strangers by express grant, or by such acts of ownership as encroachments. According to the statute claims to right of common, *profits á prendre*, and other profits (except tithes, rents and services) are not defeated after thirty years enjoyment, by showing only that such right was first enjoyed prior to that period; and after sixty years the right shall be absolute, unless it appear that the same was enjoyed by consent or some agreement.

In the case of the enclosure of copyhold lands, and there is no other provision, the allotments are freehold, though it is more usually provided that the allotments must go according to the tenure of the land where made.

With regard to the inclosure, exchange, and division of common lands, it was provided in 1845 that when part of the land to be inclosed was converted into a regulated pasture, and the residue allotted in severalty, the valuer could direct that the rights of the lord of the manor, in and to all or any of the minerals, stone, &c., under such part of the land as shall be converted into regulated pasture shall be reserved to the lord, and all the minerals under the residue should become the property of the respective allotments. He must have regard to the rights of the lord of the manor, as ascertained and declared by the commissioners and with the consent of the lord of the manor, and a majority in value of the other persons interested. When in the case of land enclosed the property in the minerals is distinct from the service, such minerals are not affected by the enclosure nor are the rights of a lessee of such minerals.

On any enclosure where the minerals are reserved to the lord or other person, there has to be specified in the provisional order whether a right to enter the lands to work minerals is to be reserved, and whether any compensation is to be made for damage to the surface.

The lord and other interested parties may agree by what persons such compensation to the allottees, whose surface may be damaged, shall be made. When minerals are reserved to the lord or any one else by provisional order, and a right is given to enter the inclosed land to work the minerals they can act accordingly. When compensation is to be made by the owners of the allotments collectively, with the lord or not, the damages must be assessed and enforced as provided by statute.

In connection with manors, the rule was that in the case of manors in ancient demesne, the freehold was not in the lord but in the tenant, and accordingly in the absence of special custom, prescription, or express conveyance, the right to the minerals was in the tenant. If the manor belonged to the tenure, called "customary freehold" here, as the freehold was in the lord the timber and minerals belonged to him and not to the tenant.

As when anything is granted the means of attaining enjoyment of it are also assumed to be granted, it follows that a grant of minerals where the owner does not hold the surface, nevertheless includes the power and right to enter and work them unless there is some restriction in the grant. Mineral property may therefore be held either by express grant or exception, or by acts creating a prescriptive right by lapse of time. Compensa-

tion ought to be given in all instruments for injuries to the surface, but if none is provided for, it could still be claimed unless the clauses in the instrument expressly prohibited it.

A freeholder, that is to say a tenant in fee simple, has as a rule an absolute right to mines and to work for minerals, but many persons have only limited interests in minerals, and it depends upon this interest as to what rights they have in respect of them. Tenants in tail could during their lives open new mines or quarries, but not so tenants for life impeachable for waste nor copyholders, except so far as special custom permitted it. Tenants for life impeachable for waste could work mines already open, and so could ecclesiastical persons.

With regard to mines and minerals in, under, or adjacent to railways, highways, canals, and waterworks, it may be briefly stated here that the minerals do not pass to a railway company, except those required for the construction of the works unless they have been expressly purchased, and the owner may, therefore, work the mines after notice. In the case of a highway the minerals belong to the owners of the adjoining soil up to the middle of the way. The rules with respect to railways apply generally to canals. The undertakers of waterworks are not entitled to the minerals under the land, but they may be purchased.

The article in next issue will treat on "Working the Coals—Repairs—Notices to Quit."

ROTH'S METHOD OF SHOT-FIRING.

DR. ROTH has proposed several chemical methods of shot-firing, but the one most suitable for mines is shown in the figure, of which the following is a description*:—

The glass jar, B, filled about half-full with 10 to 15 cu. centimetres of concentrated oxymuriatic acid, is connected by means of a thin lead pipe, C, of 1 to 1½ ms., inside diameter, which passes through the stopper and nearly to the bottom of the jar, with the cartridge, A, in the shot-hole, and its detonator, D, that contains in the front end, which is free from detonating substance, powdered metallic antimony. In order to determine an explosion a "pill," F, consisting of permanganate of potash or other salt evolved from chlorous acid, and covered with a more or less thick coating of zinc oxide, or other substance that evolves no gas when brought into contact with acid, is introduced into the inside of the jar, which is afterwards made tight by the stopper with the flexible lead pipe, L.

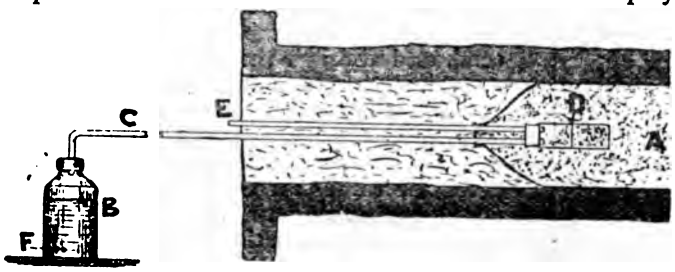
So soon as muriatic acid and permanganate of potash, or the substances that may be constituted by them, come into contact with one another, chlorine is evolved, which, conducted through the lead pipe on to the metallic antimony, unites with it, while producing flame and constituting chloride of antimony. The pipe or channel, E, serves to make a way out from the inside of the detonator through the chlorine for the expelled atmospheric air; but if the cartridge contains a free space this precaution is superfluous. The flame produced by the action of the chlorine on the metallic antimony fires the detonator and, consequently, the whole charge. In order to allow sufficient time, between the introduction of the pill into the glass jar and the commencement of the chlorine disengagement, for the man firing the shot to reach a place of safety, it is necessary to coat, more or less thickly, the solid material giving out chlorine with a substance, like zinc oxide, which is soluble in muriatic acid without disturbing gas evolution. For a glass jar, containing 15 cubic centimetres (nearly 1 cubic inch) of concentrated muriatic acid, pills are used, which, for a weight of 2 to 3 grammes of permanganate of potash, are covered with a zinc oxide coating, 1 to 2 mm. thick. By these means the acid may first, by dissolving the coating—that is, after a space of time depending upon the thickness—evolve chlorine from the substance used for its production. This method of carrying out the invention affords the possibility of determining the explosion within a given space of time, as is the case when safety-fuse is used—only without its danger—and, indeed, with a length of pipe only exceeding by about 15 c.m. (6 ins.) the distance between the mouth of the shot-hole and the place occupied by the cartridge.

In the same manner as the sulphuric acid and chlorine or lead peroxide and metallic antimony above-mentioned, other re-acting substances may be used—for instance, as one of them, hydrogen, and as the other, platinum sponge or platinised asbestos. It may here be pointed out that the necessary specific gases for the ignition of the separate solid or

* From communications to *Glauckauf*, of Essen-an-der, Ruhr, by Herr Ed. Cremer, Mining Engineer.

liquid substances may also be stored in gas-holders, or in a compressed form enclosed in iron cylinders, and led through a long special pipe to the detonator or cartridge, the contents of which are to be fired.

As an example of the manner in which fluid and solid substances may determine an explosion, the following arrangement may be adopted :—



A glass jar, like that shown in figure, or in place of it, a lead receptacle, of about 1½ c.m. ($\frac{19}{32}$ in.), inside diameter, and 7 to 8 c.m. (means 3 in.) long, contains about 10 cubic centimetres (0·6 cu. in.) of concentrated sulphuric acid. Into the latter dips, nearly to the bottom, a lead pipe, of 1 mm., inside diameter, leading to the inside of the cartridge that is introduced into the shot-hole and terminating concurrently with another similar pipe (as in the former case mentioned above) for taking off the air from the inside of the cartridge—at a mixture of potash chlorate and sugar, in the proportion of three parts potash chlorate to one part of sugar—occupying the place of the antimony in the former case. No detonator is required if the charge consists of black powder, as is the presumption in all the cases hitherto mentioned. The mixture of potash chlorate and sugar, therefore, assuming the form of a long cylinder, several millimetres thick, or loose, merely contained in a paper case, reaches directly into the powder. If now a sufficiently large "pill," consisting of potash bicarbonate, be thrown into the sulphuric acid receptacle, it will generate carbonic acid, which, pressing upon the sulphuric acid, will force it through the pipe into the explosive igniter of the cartridge.

In the inventor's opinion the two following points must specially be borne in mind. The first is that wherever a combustible gas having the character of hydrogen is used as the igniting medium, it must be led in metal pipes of not more than 0·7 mm., inside diameter. With such a small conducting pipe explosion of a mixture of air and hydrogen cannot take place, which might, however, ensue if a pipe of more than 1 mm. diameter be employed, on the same principle as that on which the Davy safety lamp is founded. It is evident from this that the introduction of hydrogen can only be effected from a space deprived of air. The second point is that any number of shots may be fired simultaneously by means of a single jar; but it stands to reason that a separate pipe must be employed for each cartridge.

This method may be used perfectly well in underground workings, as it only requires a 2 mm. pipe, of the same length as the safety-fuse now employed. The necessary acid, contained in a thick bottle, may be carried, with a special stopper, by the miner in his pocket. The channel for taking off the air of the cartridge charged into the shot-hole may be formed by means of a wire, from 1 to 2 mm. dia., inserted in the top of a (horizontal) hole while it is being tamped, and afterwards withdrawn. Finally, as regards the small jars, of which a man can carry 50 and more about with him, there is no more technical difficulty than occurs with the necessary cutting open lengthwise of the safety-fuse at the end.

A great improvement has been introduced by the inventor in generating chlorine by the action of muriatic acid on permanganate of potash. As on throwing the permanganate of potash into the muriatic acid an active disengagement of chlorine is effected, which might fire the shot sooner than expected, the "pill" is enclosed in a small piece of lead pipe, both ends of which are stopped with carbonate of zinc. The effect of this precaution is to prevent the permanganate of potash from acting before the zinc carbonate is dissolved. The space of time that must elapse before firing may also be regulated by the thickness of the carbonate stopping.

It may be stated in conclusion that although the cost of this method is at present slightly in excess of that by the so-called safety-fuse with ignition by means of steel and tinder, the increased cost is more than compensated by the absence of danger from firedamp explosion.

ANSWERS TO CORRESPONDENTS.

Elementary Student.—Refer to Question 1 of this issue for "Boyle's Law."

Shadrach Chadwick.—You can get a T-square of any size. Of course it depends upon what you purpose using it for. The same remark applies to the scale; perhaps a 20 or 30 scale may be most suitable.

J. Davies.—Will consider your suggestion.

EASY LESSONS ON

MINE VENTILATION.

By J. CARTER, First-Class Certificated Manager.

(Commenced in No. 9, Vol. III.)

SPLITTING OF AIR-CURRENTS.—Continued.

EXAMPLE V.—An airway passing 30000 cubic feet of air per minute, whose area is 36 feet, what quantity will pass through an airway of 64 feet area? Pressure and rubbing surface the same in each case.

The quantities of air that will pass in airways of different areas, other things being equal, is according to the square root of the area multiplied by the area, thus:—

$$\frac{\sqrt{36} \times 30000}{\sqrt{64}} \times \frac{36}{64} = 22500 \times {\cdot}563 = 12617{\cdot}5$$

EXAMPLE VI.—Suppose a mine to be ventilated by six different splits or air-courses, passing 10000 cubic feet in each split:—

1st Airway,	1000 feet long,	Area,	10 feet.			
2nd	,,	1500	,,	,,	?	,,
3rd	,,	2000	,,	,,	?	,,
4th	,,	2500	,,	,,	?	,,
5th	,,	3000	,,	,,	?	,,
6th	,,	3500	,,	,,	?	,,

Airways that are to be made of different lengths and of such an area as to pass equal quantities with the same pressure can be apportioned according to the formulæ:—

$$A = \frac{q}{\sqrt[3]{\dfrac{u}{K\,S}}} \qquad \begin{aligned} A &= \text{Area} \\ q &= \text{Quantity} \\ K &= \text{Co-efficient of friction} \\ S &= \text{Rubbing surface} \end{aligned}$$

To pass equal quantities with the same pressure in the above airways the areas will be found as follows:—Take the perimeter to be the same in each case, then we can take the length in feet as rubbing surface. u in the first airway will be found thus:—

$$u = \left(\frac{K\ S\ V^2}{A}\right) \times q$$

$$\therefore u = \frac{{\cdot}0217 \times 1000 \times 1^2}{10} \times 10000 \times 2{\cdot}17$$

$= 21700$ units of work, that will be expended on each airway, therefore, to find the areas of the other roads we must apply the above formulæ in each case.

2nd Airway—

$$A = \frac{10000}{\sqrt[3]{\dfrac{21700}{{\cdot}0000000217 \times 1500}}} = \frac{10000}{873{\cdot}5} = 11{\cdot}44$$

3rd Airway—

$$A = \frac{10000}{\sqrt[3]{\dfrac{21700}{{\cdot}0000000217 \times 2000}}} = 12{\cdot}59$$

The others can be apportioned and the value found by the formulæ as previously shown, the areas will then be as follows:—

4th Airway	$A = \dfrac{q}{\sqrt[3]{\dfrac{u}{K\,S}}}$	=	13·57
5th Ditto	ditto		14·43
6th Ditto	ditto		15·18

Of course, this question can be simplified, because the quantity (q), the power (u), and the co-efficient of friction (K) are all the same, therefore, we cancel the equation—

$$\frac{q}{\sqrt[3]{\dfrac{u}{K\,S}}}$$

and reduce it to the following simple method, $\sqrt[3]{S}$, so that the areas will be simply in proportion to the cube roots of the rubbing surface, and as the perimeters are all equal, the areas will be as the cube root of their lengths, thus: $\sqrt[3]{S} : A :: \sqrt{S}$ is to the area required.

These can be proved as to their correctness by using Atkinson's formulæ and finding the amount of pressure (P) for the assumed quantity, and this pressure ought to be the same in each case:—

1st $\quad P = \dfrac{{\cdot}0217 \times 1000 \times 1}{10} = 2{\cdot}17$

2nd $\quad P = \dfrac{{\cdot}0217 \times 1500 \times {\cdot}763876}{11{\cdot}44} = 2{\cdot}17$

3rd $\quad P = \dfrac{{\cdot}0217 \times 2000 \times {\cdot}630436}{12{\cdot}59} = 2{\cdot}17$

4th $\quad P = \dfrac{{\cdot}0217 \times 2500 \times {\cdot}543069}{13{\cdot}57} = 2{\cdot}17$

5th $\quad P = \dfrac{{\cdot}0217 \times 3000 \times {\cdot}480249}{14{\cdot}43} = 2{\cdot}17$

6th $\quad P = \dfrac{{\cdot}0217 \times 3500 \times {\cdot}434281}{15{\cdot}18} = 2{\cdot}17$

I will next take an example of a continuous undivided road, of various dimensions, and passing one current of air. This we will reduce to one typical road, of uniform size throughout, and for the purpose of calculating the same the following rule may be employed:

$$L = \frac{A^3}{p} \times \frac{S}{a^3}$$

L = Length of same, A = Area of typical road, p = Perimeter of same, S and a = Rubbing surface and area, respectively, of the original uneven road at each dimension, $A = 64$, $p = 32$.

EXAMPLE.—An airway having the following dimensions, and from these measurements it is desired to calculate the length of a typical road, which will be 8 feet square and uniform throughout, that will offer the same resistance as the original one.

With road, 8 feet square—

$$\frac{A^3}{p} = \frac{262144}{32} = 8192$$

Length of Airway in feet.	Size.	Area.	Perimeter.	Rubbing Surfaces.
800	8 × 5	40	26	20800
600	5 × 5	25	20	12000
500	9 × 4	36	26	13000
700	6 × 4	24	20	14000
300	4 × 5	20	18	5400

2900 feet, total length of original road.

To find the length of typical road in sections proceed thus:—

$$\frac{A^3}{p} \times \frac{S}{a^3} = L$$

I have shown that $\frac{A^3}{p} = 8192$, therefore, we can proceed:—

1st portion—

$$L = 8192 \times \frac{S}{a^3} = 8192 \times \frac{20800}{64000} = 2662$$

2nd portion— $L = 8192 \times \frac{12000}{15625} = 6283$

3rd portion— $L = 8192 \times \frac{13000}{46656} = 2277$

4th portion— $L = 8192 \times \frac{14000}{13824} = 8290$

5th portion— $L = 8192 \times \frac{5400}{8000} = 5530$

Length of typical road 25042

We now see that the length of the new road would be 25,042 feet; the old one being 2,900 feet. This points out to us the desirability of having airways of good dimensions, because an airway, 8 feet square and 25,042 feet in length, only offers the same resistance as the original airway of various sizes, but only 2,900 feet in length.

We can prove this to be correct by Atkinson's formulæ. For the sake of calculation, say we have 10600 cubic feet of air per minute passing, find pressure in each part of the original road, thus—

lbs. pressure per sq. foot.

1st $P = \frac{\cdot 0217 \times 20800 \times \cdot 070225}{40} = \cdot 7925$

2nd $P = \frac{\cdot 0217 \times 12000 \times \cdot 179776}{25} = 1 \cdot 8725$

3rd $P = \frac{\cdot 0217 \times 13000 \times \cdot 071209}{36} = \cdot 5583$

4th $P = \frac{\cdot 0217 \times 24000 \times \cdot 195364}{24} = 2 \cdot 4730$

5th $P = \frac{\cdot 0217 \times 5400 \times \cdot 2809}{20} = 1 \cdot 6457$

Pressure required for the original road 7·3420

We will calculate the pressure for the typical road, and this should work out the same as the above to prove the correctness of the method.

Typical road, 8 feet square and 25,042 feet long, find pressure to pass the same amount of air, 10,600 cubic feet:—

$$P = \frac{\cdot 0217 \times 801344 \times \cdot 027225}{64} = 7 \cdot 397$$

Practically this is the same as the original one, the difference is due to not carrying the decimal points further.

(To be continued.)

AWARDS

FOR ANSWERS TO COMPETITION QUESTIONS.

Question 1.—George Arthur Hawes, Holy Trinity Terrace, East Murton, Co. Durham.

Question 2.—Thomas Hill, Crosby Villa, By Maryport, West Cumberland.

Commended.—S. Davies, H. Hall, J. Jackson, J. Harrison, Thos. Banks, W. E. Shaw, A. Brydson, J. Crone, G. Daykin, W. Johnson, T. Webster, R. Gregory, M. Mourley, A. H. Meakin, T. Martin.

ACCIDENTS IN MINES AND THEIR PREVENTION.

THE following table gives the number of fatal accidents, tabulated as miscellaneous underground, during the year 1894, as compared with a total of 265 in 1893:—

By Explosives	12
Suffocation from natural gas	4
On inclined and engine planes	57
By trams and tubs	59
By machinery	9
Ropes and chains breaking	6
Sundries	30
Total	177

The accidents occasioned by the use of explosives underground would be greatly minimised, as has been previously stated, by the total abolition of gunpowder and naked lights, as many of the accidents occur while handling the explosives. Another circumstance to which accidents by explosives are due is the firing of shots in series. Shots should be fired singly, unless exceptional conditions necessitate otherwise, as it frequently happens when firing two or more shots together, that one hangs or else misses fire, and no one is the wiser until an accident occurs. It is improbable that a shot will hang fire when fired by electricity, but the detonator may, from some reason or other, miss fire and may subsequently cause serious damage, so that even with electric firing of the charge there is still danger if the shots are fired in series. Another frequent cause of accident, but one which is already provided for by legislation, is the unramming of shots. Stricter discipline on the part of the management is the only further prevention of these.

No less than 116 deaths were caused by wagons, half the number being on inclined and engine planes. Many deaths are caused on self-acting planes, and the best preventative is to prohibit persons from travelling on the plane while working. The necessity for this rule is fully recognised at many collieries, and it is required to signal to the "jigger," or attendant of the self-acting incline not to start the train before travelling up the plane. The same precaution is taken in coming down—the jigger awaiting the signal of the persons travelling down before starting. The same precaution is often taken with engine planes, but it is not every circumstance that would admit of this rule. In short steep roads it is little inconvenience to stop the working while the men are travelling, but when the road is of considerable length, this is altogether out of the question. The only resource then is to have numerous man-holes and good roads, so that the men can quickly get to a place of safety. It is apparently a difficult matter to compel colliery managers to provide the requisite number of man-holes required by the Act, and to this may be attributed many of the accidents on inclined and engine planes. Gang-riders and pony-drivers often lose their lives by being jambed against the roof timbers whilst riding on the tubs. When there is not a fair clearance between the top of the tub and the roof timbers, the men should not be allowed to ride; it is out of all reason to expect a man to safely ride a gang when the small tubs are "roofing." There should be a good stop-block in use on self-acting planes to prevent the full tubs running away before the rope is attached. The use of "scotches" or "wheel-pins" should be strictly enforced where the trams are moved by manual labour on inclines, and putters or drawers should be prohibited from drawing in front of the trams, unless it be to put them on the road when they have been derailed.

The precautions to be taken in the use of machinery underground are to fence it off thoroughly and to place it in charge of reliable and sensible persons. Inundations of water from old workings have within recent years caused numerous deaths (included under miscellaneous underground) and have shown plainly the necessity of correct mine plans. Surveyors, as well as colliery managers, should be compelled to pass an examination to show clearly whether they were capable of surveying a mine properly. Needless to say, however, examinations will not provide against carelessness to which, no doubt, the errors are chiefly due. In addition to the precautions required to be taken by the Act when approaching old workings likely to contain dangerous accumulations of water, the following should be adopted:—For boring the exploring holes a machine (such as Burnside's) should be employed, by which means water tapped by the borer could be effectually stopped off, or its flow regulated; and in addition to this appliance a safety, or strongly built water-tight door should be fitted up a short distance from the face—such door to be kept shut whilst shot-firing and during the time the workmen are absent from the exploring places.

The number of fatal accidents on the surface are perhaps not in excess of those which occur in other somewhat similar industrial works, the number of deaths for the past year being 112. Of these, 14 were caused by machinery, 67 on railways and tramways, and 31 from miscellaneous causes. It will be noticed that nearly 60% occurred on railways and tramways. To minimise these the clearance between the sidings, about the screens, should be as free from posts and obstructions as possible, and should give ample space for convenient travelling backward and forward, even when full of wagons; special bars or props should be provided for spragging the wagons. A special rule, enforced in Scotland during the past year, is to the effect that pointed wooden sprags, not exceeding 3 feet in length, must be provided for spragging railway wheels when spragging is necessary, and the use of other timber for this purpose is prohibited.

The writer has now reviewed the principal causes of accidents in and about mines, and has, whenever it was deemed necessary, offered suggestions for minimising the same; some of these may be feasable and practicable, others not. At the same time it must be understood that no sweeping condemnation has been made without due deliberation from an economical and practical point of view, and excepting the suggested total abolition of gunpowder and open lights there is nothing that can be considered as material affecting the cost of production, perhaps not in the slightest degree. It will, no doubt, be thought that the work of the mines' inspectors would be increased. This is true, as also is the fact that the present system of mines' inspection is inadequate inasmuch that the work is already far too great to be properly attended to by the existing staff. At the present time almost all the inspector's time is taken up with investigating accidents with a view to legal proceedings in the event of the law having been infringed. It is, no doubt, a wise policy to punish the guilty, so that the deed may not be repeated, but, in the writer's opinion, the inspectors would be employed to greater advantage in inspecting the collieries, and in authorising or advocating changes which would minimise the risk of accident. It is a dear game finding out offences at the cost of numerous lives. Say a fatal accident occurs, the inspector visits the site of the accident and at the inquest he states that had he previously known such a condition of things existed, as he found on his visit, he would have most certainly advised a change, so that had an inspection been made previously there would have been a probability of the accident being prevented. What is wanted, therefore, is that the inspectors should have greater opportunities of inspecting in a general manner and not wait for an accident. It must not be thought for a moment that an insinuation is made that the inspectors do not do their duty properly—far from it. It has been our good fortune to have a number of energetic, intelligent, and unbiased men acting as mines' inspectors, and we have profited accordingly. There is no doubt that the mines inspectors, taken as a body, are overworked. We find from the official reports that it is no unusual occurrence for an inspector to make over 300 visits and to travel 12,000 or 15,000 miles in the execution of his duty in one year, besides attending to many other things which are included in his work. It is, therefore, the writer's opinion that the staff of inspectors should be greatly increased and that mines should be more generally inspected.

(*Concluded.*)

COMPETITION QUESTIONS.

We make an uniform award of 2s. 6d. to the sender of the best answer to each of the questions given. Answers to be as brief as possible, and sketches must be made when necessary. One or both questions may be answered.

Envelopes to be marked "COMPETITION," and to reach us before September 20th, 1895.

We invite readers to forward questions for this competition.

(1) A large fall occurred on one of the main roads of a mine. A man is buried under it, but is not dead. It is a fiery mine. State your mode of procedure, and from which end of the fall you would commence to clear away.

(2) What size of shaft and what winding arrangements generally would you employ to wind 1000 tons of coal per day from a depth of 800 yards? Take capacity of tubs as 10 cwt.

PRIZE ESSAY.

INDICATORS AND INDICATOR DIAGRAMS.

We offer a Prize of 10s. and a Special Certificate for the best Essay on "Indicators and Indicator Diagrams, submitted to us on or before September 12th. Articles to be illustrated and to cover about eight foolscap sheets, or less, ordinary writing.

Papers to be marked "Essay," and to be sent independent of any other matter.

THE ENGINEERING OF COLLIERIES

Being a Treatise on Colliery Machinery, Appliances, and Constructions.

By T. A. O'DONAHUE.

(Commenced in No. 9, Vol. III.)

WINDING.—CONTINUED.

SAFETY APPLIANCES.—The principal safety appliance applied to winding may be said to be the detaching hook. This is a hook fitted beween the suspending chains of the cage, and the winding rope and its duty is to detach or release the rope in the event of the engineman neglecting to stop the engine when the cage has reached the surface. As has been previously stated, the engines used for winding are direct-acting, and as the circumference of the drum often exceeds 60 feet, if the engine is allowed to continue the wind for one stroke beyond the proper limit it may be sufficient to pull the cage to the top of the headgear and cause considerable destruction and often result in loss of life. It is not often, however, that lives are now lost from this cause, as accidents are prevented in the case of an overwind by the general adoption of the detaching hook.

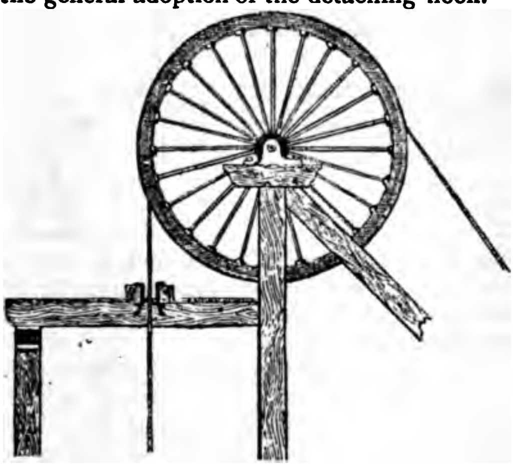


Fig. 36.

There are numerous kinds of detaching hooks, but the general principles are the same in all. The winding rope passes through an iron ring suitably placed at the top of the headgear, and in the event of an overwind the detaching hook is drawn partly into the ring, which is, however, too small to allow the lower portion of the hook to pass through. The pressure thus brought to bear upon the lower portion of the hook in endeavouring to pass through the ring causes a rivet to be cut and a shackle or link to which the rope is connected is released and the rope is detached. An additional feature of the hook is that it also supports the cage. By the same movement that the rope is released the upper portion of the hook opens outward and projecting fangs engage on the ring and the cage is thus safely secured until the rope is reattached. The position of the ring or cylinder in the headgear is shown by fig. 36, which is the design employed with the Ormerod detaching hook. Other good types of hooks are Walker's, King's, and West's. Even when the hook acts properly and detaches the rope, there is a danger of the shock shattering the supporting ring or beam in the headgear, or the hook or the suspension chains may give way with the unusual strain and the cage may fall down the shaft. To prevent such an accident, therefore, it is wise to have stops fitted in the headgear a little below where the cage would be when detached, which will arrest the fall of the cage under such circumstances. A possible arrangement of such stops is shown by fig. 37, and an

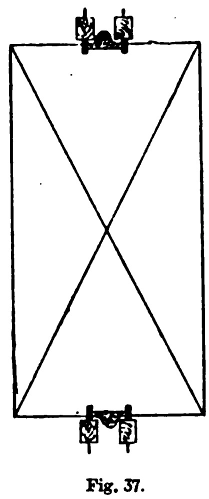


Fig. 37.

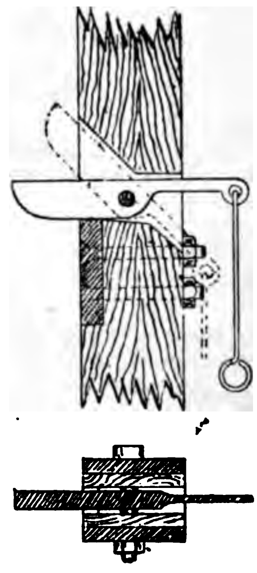


Fig. 38.

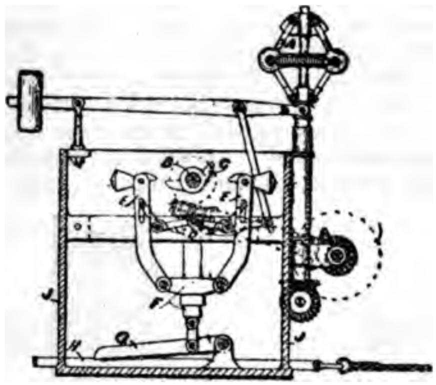
enlarged section and plan of the stop itself is shown by fig. 38. There may be two, four, or more stops for each cage and they may be placed in any convenient position, either at the ends or the sides of the cage travel. In the illustration they are shown fitted at the ends of a cage in the troughs of the rope

conductors, but perhaps the more usual position is at the sides, as the tubs are usually changed from the ends. It will be seen by the enlarged sketch that the cage in its ascent will not be impeded by the stops as they will move in the position shown by the dotted lines, but immediately the cage has passed, the weight of the stops causes them to assume their original position, and should the cage descend, its fall will be arrested. The stops are also very convenient for supporting the cages while the rope is being reattached after an overwind. The back of the stop is shown terminatirg in a ring to which is attached a bar, at the lower end of which is a handle. This is to afford facility for examination to ascertain whether the stop is in working order and also to raise the stop into the position shown by the dotted lines, when it is required to lower the cage after detachment.

firm grip, and there is the possibility of the guide ropes breaking with the shock. There is also another danger: winding, nowadays, is so quickly performed that the safety appliance is liable to come into action when not required and perhaps create a calamity it was intended to pervert.

A few appliances have been designed with a view to actually preventing the overwind rather than rendering the overwind safer, and one of the best of this kind is "The Visor," which has been in use for a considerable time. The following is the description supplied by the inventor :—

The accompanying illustration (fig. 39) represents Bertram's patent, "The Visor," designed for the prevention of rapid overwinding at collieries and other places. This diagram has been specially prepared to illustrate, popularly,



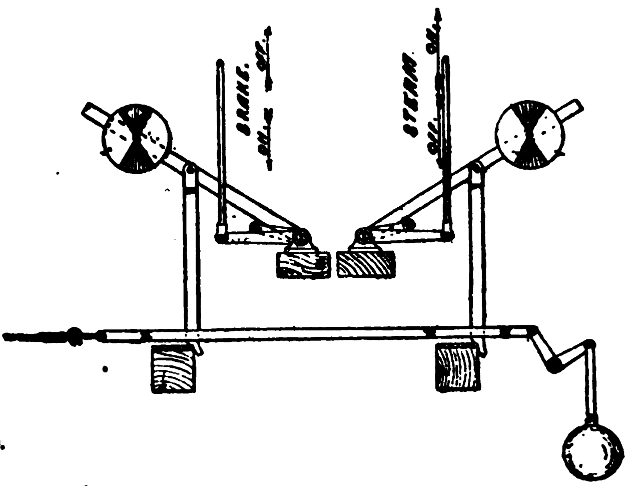


Fig. 39.

Numerous appliances for stopping and supporting the cage in the event of the rope breaking have been designed and many are in use on the continent, but they have found little favour in this country. It is seldom that a winding rope breaks, in fact there is no reason why, with proper care, they should break, and as the use of the safety appliance opens up another source of danger it is doubtful if they will ever come into general use. Almost all these appliances are actuated by a spring which is kept in compression while the load is on the rope, but should the rope break the spring is released and gripping arms are forced into the guides. With wooden guides the grips act fairly well, but with wire-rope guides it is much more difficult to secure a

the action of the machine, and it will be understood that the positions occupied by the machine and its adjuncts are not shown with absolute accuracy.

The governors, A, which do little besides act as speed indicators, are driven by suitable gearing from the crank shaft, or drag crank shaft, of the winding engines, as also is the worm wheel shaft, B. The latter makes, approximately, one revolution per winding, and carries beaked cams, C, which can be adjusted to the required positions. As the speed of the engines gets up, the governors rise, and move, through the medium of levers, D, the vertical arms, E, with hooks attached, and bring these latter into the line of march of the cams, C, on worm wheel shaft.

Towards the conclusion of the winding, if the speed of the engines is reduced suitably, the governors fall and bring the levers, E, with hooks attached, out of the path of the cams on the worm wheel shaft, and into the position as shown on diagram, and the cams pass the hooks without making contact. If, however, through any cause the speed of the engines is not suitably reduced as the cages approach the top and bottom of pit-shaft, the governors do not collapse, and one of the beaked cams on worm wheel shaft makes contact with one of the vertical levers, E, with hooks attached, the sliding frame, F, is drawn up, the paw, G, is raised out of the notch in the bar, H, in the bottom of the frame, J; and the weight at the other end immediately falling, upsets the propped and weighted levers, L, and applies the steam and foot brakes and shuts off the steam, and thus arrests the engines. The arresting commences about two or three revolutions from the top, giving time to pull up gradually. After action, all can be reinstated in a few minutes and the winding resumed. It will thus be seen that so long as the engines are under proper control by the engineman nothing results; but if speed is kept up too long, then the machine does what the engineman ought to have done earlier in the run.

One of these machines has been in daily use for a considerable time at the Alexandra Pit of the Wigan Coal and Iron Company, Limited, and has been repeatedly tested, with uniformly satisfactory results. In this machine there are two sets of governors, each adjusted and speeded for different points in the winding.

It is quite possible to make a relatively slow overwind with this machine attached—how fast depending on how the governors are speeded in relation to the engines. The governors can be varied in speed at will, to suit the different requirements of the different pits. There is also an arrangement which can be attached, whereby, in the event of a slow overwind taking place, or of the engines being started the wrong way, the brakes are applied and steam shut off, independently of the speed at which the engines are going. The machines can be readily applied to all classes of winding engines, whether vertical or horizontal, and provided the brakes are of sufficient power, both ascending and descending cages will be arrested before reaching their destinations, thus affording protection to both ascending and descending men.

(To be continued.)

ANSWERS TO COMPETITION QUESTIONS

IN No. 18, VOL. III.

THE BAROMETER AS AN INDICATOR OF DANGER.

(1) Do observations tend to prove that the barometer is of any service as an indicator of danger in a mine.

Answer.—Yes; emphatically, yes. The barometer is of great value and utility in giving notice of an increased escape of CH_4 or firedamp, in certain, or more properly, variable states of weather. As the firedamp is pent up by the counter-poising pressure of the atmosphere, any barometrical fluctuation or lessening of atmospheric pressure, as indicated by a fall in the mercurial column, is a sure presage of an extra flow of this gas, and this calls for the ventilation power to be increased in order to circulate a larger volume of air to remove the enemy.

The great majority of mine explosions occur during a low state of the barometer, or, as may be more technically stated, a fall of the glass. The more sudden the fall, according to practical observation, the greater is the danger of explosion. Not only does an undue escape of gas take place from the coal strata by a fall of the barometer, but the waste air of the abandoned parts of the mine, viz., the goaves, remote excavations, and elevated parts. An atmosphere, frequently charged with an explosive mixture of firedamp, expands in volume and increases the danger of explosion.

It will thus be seen that the gas seceding from the goaf comes in the path of the ventilating current charging it with explosive gases, which coming in contact with the light or flame of the workmen's lamps renders the danger to explosion imminent. By observing the barometrical fluctuations we are put on our guard to apply the best means to ensure safety, and in all cases to carefully observe the side of goaves next to working faces.

From the following fact we will readily see the advantage of observing the indications of the barometer:—

According to the law of Mariotte or Boyle, "the volume of a gas is inversly as the pressure it sustains." Then, suppose we have an old waste of goaf, with 10,000 cubic feet of firedamp and the barometer standing at a nominal state of 31 inches of mercury, how would the gases be influenced by a fall of the mercury to 29 inches? The result is

obvious. We have a reduction of pressure equal to 2 inches of mercury; thus in this case we must multiply the original volume by 31 and divide the result by 29, which will give a considerable increase in volume:—

29 : 10000 :: 31 : 10689

Thus, we see, our original volume is increased from 10000 to 10689 cubic feet by a fall of 2 inches of mercury. By this increase it must occupy more space, hence its retreat from its own locality to the path of the ventilating current.

An exceedingly sudden fall of the barometer is accompanied by much more dangerous effect than a much larger fall, that is, presuming the time extending during the period of falling is considerable. In the case of a sudden fall of the barometer we should immediately see to those places which most necessitate careful attention, and use the utmost care, influence, and means to minimise the danger resulting from such a fall.

G. A. Hawes.

MECHANICS.

(2) A simple screw-jack is employed to raise a weight of 5 tons, the screw has a pitch of $\frac{3}{4}$ inch, and the lever is 20 inch long. What power must be applied to the end of the lever? Also find W if P = 50 lbs.

Answer.—The power applied moves in a circle, whose radius is the length of the lever, which = 20 inches. In one turn of the lever the weight is raised the distance between the threads of the screw (or pitch), which = $\frac{3}{4}$ of an inch ∴ the space moved over by power = $20 \times 2 \times 3{\cdot}1416 = 125{\cdot}664$ inches. The distance the weight is raised in one revolution of power = $\frac{3}{4}$ of an inch. The work done by power in one revolution = power $\times 20 \times 2 \times 3{\cdot}1416$ ∴ power $\times 20 \times 2 \times 3{\cdot}1416$ = weight $\times \frac{3}{4}$ inch. Weight = 5 tons $\times 2240 \times \frac{3}{4}$ inch = 8400 lbs. $\div 20 \times 2 \times 3{\cdot}1416 = 125{\cdot}664 = 66{\cdot}84$, which is the power applied at the end of the lever; or W × motion of W = P × motion of P, which becomes

$$\frac{5 \times 2240 \times \frac{3}{4}}{20 \times 2 \times 3{\cdot}1416} = 66{\cdot}84 \text{ power applied.}$$

Also find W if P = 50 lbs.?

W = P × motion of P ÷ motion of W, which becomes—

$$\frac{50 \times 20 \times 2 \times 3{\cdot}1416}{\frac{3}{4}} = \frac{6283{\cdot}2}{\frac{3}{4}} = \frac{6283{\cdot}2}{1} \times \frac{4}{3}$$

$= 8377{\cdot}6$ lbs. $= 3{\cdot}74$ tons weight, which can be raised by 50 lbs.

Thomas Hill.

EDITORIAL NOTES.

The accompanying table gives the official return of the number of persons killed and injured in and about mines during the month of July, 1895.—

Cause of Accident.	Killed. No. of Persons.	Killed. Per cent.	Injured. No. of Persons.	Injured. Per cent.
Explosions of Firedamp	4	5·63	17	5·52
Falls	34	47·89	130	42·21
In Shafts	4	5·63	10	3·25
Miscellaneous	22	30·99	112	36·36
Surface do.	7	9·86	39	12·66
Total	71	100·00	308	100·00

In the corresponding month of last year the number of persons killed in and about mines was 60 and injured 293. So that in comparing the two months we find that 11 more fatal and 15 non-fatal accidents occurred in July of this year than July, 1894. This shows a considerable increase in both fatal and non-fatal accidents for the corresponding months. What we wish to draw the attention of managers and deputies to is the fact, that nearly 48 per cent. of the fatal accidents are due to falls, and 42·25 per cent. of non-fatal accidents are due to the same cause. It clearly points out that this class of accidents is very frequent in mines, because in looking over the above figures one cannot consider them over carefully without being struck by the great per cent. of lives lost and injuries received from this one source alone. Surely if more specific rules as to setting timber were given and a stricter discipline enforced, this class of accidents would become considerably reduced.

* * *

The annual report of the Department of Mines and Agriculture of New South Wales for 1894 has just been published. The output of coal for 1894 was 3,672,076 tons, of the value of £1,155,573, which is an increase of 393,748 tons, but a decrease in value of £16,149, due to the very low price prevailing for this product during the year. The number of collieries under inspection was 95 coal and 5 shale, and the number of men employed, 9,428. There were 7 fatal and 40 non-fatal accidents.

* * *

We have received the July number of the journal of the British Society of Mining Students, the following being the contents:—Foundations, by W. H. Mungall. A novel feed for colliery horses, by J. J. Joynes. Horse-keep at East Howle Colliery, by Hy. Palmer; and notes on surveying, by T. H. Cockin. The first and last of these papeas are especially interesting, though we cannot agree with the whole of Mr. Cockin's paper on surveying.

* * *

The following gives the comparative illuminating power of the various safety lamps, the Sperm candle being taken as the unit:—

Sperm Candle	1·00	Evan Thomas	0·45
Geordy	0·10	Marsaut, 3 gauzes	0·45
Davy	0·16	Marsaut, 2 gauzes	0·55
Clanny	0·20	Howat's Deflector	0·65
Mueseler	0·35		

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MINING

A JOURNAL DEVOTED TO THE INTERESTS OF MINING

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CONTENTS.

FOUNDATIONS *

By WALTER H. MUNGALL, B. Sc.

THE importance of a sound and unyielding foundation for machinery or other erections has long been realized, and at an early stage in the work of opening and fitting a new colliery, the engineer has to turn his attention to this subject. The first engine that is to be used in sinking a shaft requires to have a foundation previously provided for it. Boilers and chimneys; the permanent winding, pumping, and haulage engines; head-gear and screening plant all require foundations. In the present article, the subject will be dealt with only so far as it lies within the province of the mining engineer, and it is not intended to enter into any discussion of the theory of foundations.

A foundation in its simplest form consists of an excavation in the ground of such form and dimensions as will give a firm base for the superstructure. Such a foundation is all that is required for comparatively light structures, not subject to sudden and severe strains. But for most structures about a colliery such a foundation is quite inadequate, and the excavation is partially or completely filled with some material which will form a firm and solid base. In many cases, as for example in the case of a pulley frame, the area of the base of the structure is small in comparison with the weight upon it, and the pressure per unit area is consequently great, greater often than simple earth foundations can resist. To reduce the pressure per unit area it is customary to form the excavation of of sufficient size, and subsequently fill it with some solid material as masonry, brickwork, or concrete, through which the pressure is distributed to any desired extent. Before proceeding with the construction of foundations, the first thing to be ascertained, after an aquaintance with the nature of the ground, is the approximate weight to be supported, and the foundations must be so designed that the pressure per unit area will be well within the limits of safety. The direction of the pressure must also be taken into account, and the base of the foundation should be formed as nearly as possible at right angles to the direction of pressure upon it. As a general rule also, the line of the resultant pressure on a foundation should pass through the centre of gravity of the foundation, or as near thereto as possible.

In some few cases a firm and sufficient foundation is readily obtainable on rock, in which case all that is necessary to prepare it for the superstructure resting on it, is to cut away all loose or decayed parts, and to hew or dress the surface of the rock to suit the form and pressure of the structure to be erected. When the surface of the rock is irregular, it may be necessary to fill hollows in it with masonry or concrete. It is customary in engineering practice to allow for stone structures a factor of safety of not less than eight, and for foundations on rock the pressure should not exceed, at any point, one-eighth

* From the Journal of the "British Society of Mining Students."

of the pressure required to crush the rock. Experiments on the crushing pressure of rocks have from time to time been made by various engineers of eminence, the average results of some of which are given in the subjoined table:—

TABLE OF THE STRENGTH OF ROCKS.

	Crushing Stress. Pounds per sq. inch.
Sandstone (strong)	5000 to 9000
Do. (weak)	2000
Do. (ordinary)	3000 to 5000
Limestone, compact (strong)	8000
Do. magnesian (strong)	7000
Do. do. (weak)	3000
Do. granular	4000 to 4500
Chalk	300 to 400
Whinstone (basalt)	9000 to 17000
Granite	6000 to 11000

Where the rock surface is not accessible for forming the foundation, the base of the structure has to be rested on the earth above the rock, and the total pressure must be more or less distributed as the earth is softer or firmer. In firm earth such as hard clay, clean sharp sand or firm dry gravel, the greatest pressure in general engineering practice is from 2,500 to 3,500 lbs. per square foot of bearing surface. For a superstructure that is in itself heavy, or that has to support a heavy load, or that is liable to severe strain, the foundation base must be made of such area that the pressure per square foot will not exceed the above limit. Usually the footings or lower courses of ordinary masonry or brickwork, as of an engine-house, have an additional breadth or "spread" equal to one-and-a-half times the thickness of the body of the wall when built on compact gravel or of twice that thickness when built on sand or stiff clay. A section of the base of a brick wall 14 inches thick is given in fig. 1, which shows how the requisite additional breadth of base is obtained.

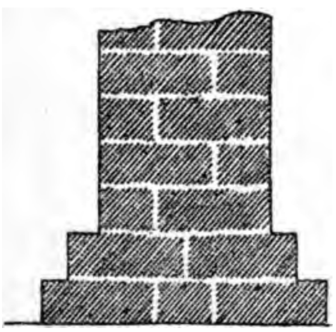

Fig. 1.

Before building on *soft* earth, additional precautions must be taken with regard to the foundations, and some other expedients must be adopted than those applicable to firm earth foundations. Of course there are degrees of softness, and no general rule can be laid down applicable to the variety of cases that may occur in practice. The simplest class of foundations on soft earth are those already referred to as applicable to firm earth, with this difference, that the base must be further increased to reduce the pressure per unit area. When softer earth, as peat moss, soft alluvial clay or silt, with, in some cases, a natural slope of one vertical to eight or ten horizontal, is met with, of considerable depth, other methods have to be adopted. These generally entail the use of timber or iron. Timber platforms are usually constructed, as shewn in fig. 2, by forming a grating of crossed beams of elm or oak which in turn is covered by planking on which the superstructure rests. The beams employed are usually from 10 to 12 inches square, and laid about 3 feet apart, the spaces between being filled with concrete.

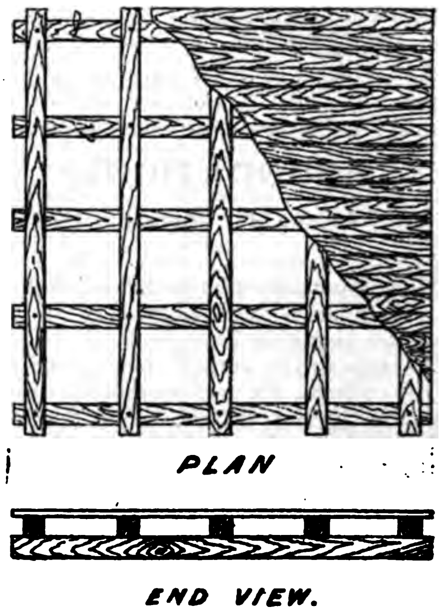

Fig. 2.

The method usually adopted, however, for securing a good foundation in very soft ground is by piling. Piles are usually of square or round timber from 6 to 9 inches diameter for piles from 6 to 12 feet long, and larger in proportion to the length, the ratio of diameter to length being in general about one to twenty. In setting the piles they are placed as close together as practicable. When piles are driven to form a rectangular or circular foundation, the outer circuit of piles should always be driven first, the work being finished

at the centre. The piles may be surmounted by a platform as above described, or simply by a layer of concrete. The most suitable timber for making piles is elm. In general practice the limits of pressure on pile foundations may be taken as 1,000 lbs. per square inch of head area when the piles are driven till they reach firm ground, or 200 lbs. per square inch of head area when the frictional resistance between the timber and the earth is the only support. In all cases where timber is thus employed in foundations, care should be taken to keep it entirely removed from the influence of the atmosphere, and to keep it wet, otherwise it will soon decay.

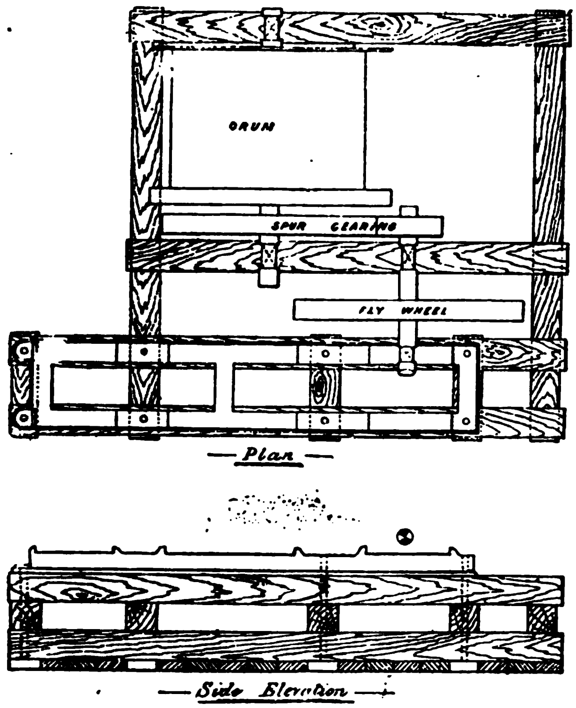

Fig. 3.

Engine foundations, as a rule, require to be raised sufficiently high above the surrounding ground to give clearance for the fly wheel, drum, or gearing, or for other purpose as also to form a sufficient weight to which to fix the engine. Engine foundations may be constructed of timber, brickwork, masonry, or concrete. For permanent work timber foundations are not to be recommended, as they are liable to early decay, but for temporary winding or pumping engines at a sinking shaft they form a convenient, simple, and cheap foundation. They are easily built and easily removed, and the material may subsequently be used for similar or other purposes. A timber foundation for a temporary geared winding engine is shown in fig. 3.

One form of engine foundation, now almost obsolete, was built of ashlar masonry, the stones being of large size, each measuring about ten cubic feet, the usual dimensions being 4 feet by 2 feet by 15 inches thick. Stones of larger size are more expensive, and were consequently seldom, if ever, used. Undoubtedly this makes a very good foundation, but it is costly and is now generally superseded by brickwork or concrete.

Brickwork built with Portland cement mortar is in very general favour, and forms an excellent foundation. The bricks should be tightly built, the joints not exceeding quarter of an inch in thickness, and the whole structure well bonded together so as to form, as nearly as possible, one solid block. The cost of this kind of engine foundation is considerably less than one of ashlar masonry.

For engine foundations, and, indeed, for all sorts of foundations about a colliery, there is much to recommend the use of concrete. It forms the best foundation, and is less costly than ashlar masonry or brickwork. Concrete is essentially a species of rubble building, the stones of which are cemented together by a mortar, usually of Portland cement and sand or fine gravel. About a colliery where, as a rule, a plentiful supply of sandstone is readily obtainable, especially during sinking operations, it may with advantage be used in the manufacture of concrete. A quantity of stone is broken to about the size of ordinary road metal, or from $1\frac{1}{2}$ to $2\frac{1}{2}$ inches diameter. This is mixed with certain proportions of clean sand and of Portland cement, the proportions of the various ingredients varying with the purposes for which the concrete is to be employed. For ordinary foundations the proportions are generally about four parts by measure of broken stones, one part of sand, and one part of cement. These, after being thoroughly mixed, have sufficient water added to make the whole a plastic mass, which is forthwith transferred to the excavation or other receptacle previously provided for it. At the same time, a number of large stones may with advantage be thrown in, care being taken that they are thoroughly bedded in the concrete, which should also fill all interstices between them. When using sandstone for

making concrete, it is not generally necessary to add sand, as in breaking the stone a quantity of sand is produced, unless the stone be very hard. By a little experience one can readily estimate whether there is a sufficient quantity of sand among the broken stones, and it becomes unnecessary to measure them out separately. Broken bricks, blast furnace slag, limestone and other materials are frequently used for making concrete. It should be noted that the concrete occupies only about two-thirds of the volume of the ingredients when unmixed.

When concrete foundations have to be raised above the level of the surface, a casing, usually formed of planks, has to be erected, of the form and height of the monolith, into which casing the plastic concrete is placed. After it has sufficiently set to permit of the casing being taken away, this should be done.

In conclusion, it may be useful to compare the cost of building engine foundations of the three classes referred to. For a set of coupled winding engines, each foundation will contain about 40 cubic yards, or say 80 cubic yards in the two, and the total cost will be approximately as under:—

80 cubic yards	Ashlar Masonry	at 55/- =	£220 0 0
80 „	Brickwork in Cement	at 16/- =	£64 0 0
80 „	Concrete (5 to 1)	at 9/- =	£36 0 0

COMPETITION QUESTIONS.

We make an uniform award of 2s. 6d. to the sender of the best answer to each of the questions given. Answers to be as brief as possible, and sketches must be made when necessary. One or all of the questions may be answered.

Envelopes to be marked "COMPETITION," and to reach us before October 4th, 1895.

We invite readers to forward questions for this competition.

(1) What size of pumps and engine would you erect to pump 600 gallons of water per minute from a depth of 100 fathoms. Give a general description of the engine you prefer with the principal sizes.

(2) Give a brief description of the generating, conducting, and appplying a current of electricity to work a pump underground.

(3) We have two fans placed in connection with the upcast shaft; each fan is 25 feet diameter and 7 feet wide. When one is going at 50 revolutions per minute, 100,000 cubic feet of air is produced with a W.G. of 1·5 inches. What quantity and W.G. would be produced if the revolutions of the fan were increased to 80. If both were going together at 70 revolutions per minute, what quantity and W.G. would you expect, and if one was exhausting through the other how would the quantity and W.G. be altered.

THE LAW RELATING TO
MINES, MINERALS, & WORKERS.

By T. F. UTTLEY, Manchester,
Author of "Factory and Workshop Inspection," Editor of "Labour Contracts," 4th Edition, &c., &c.

(Specially written for this Journal.)

II.—Working the Minerals—Repairs—Notice to Quit.

WHEN minerals are, as is usually the case, the subject of a lease, liberty is given to search for, dig, get, work, win, and carry away the minerals. As such a lease may either deal with lands wherein lie minerals, or with minerals alone; it is essential in both cases that an express right to work should be given to the lessee, and provisions with regard to compulsory working have also to be considered. A lessee of a mine will therefore be chiefly governed by the terms of his lease as to the working, and there is some difference in the terms of working a tin, copper, or lead mine, as compared with a coal mine or a quarry.

In the working of his mine a lessee has often a claim to what is called the instroke. By this term is meant the right to take minerals from a demised mine to the surface through a pit or shaft in an adjoining mine; whereas outstroke is the right of taking minerals from an adjoining mine to the surface through a pit or shaft in the demised mine. Where there is not any special grant the lessee of a mine may work the minerals by instroke, and being so entitled is not concerned to sink pits or shafts, but if it is intended to bind him to sink pits or shafts then the intention ought to be clearly indicated. Of course, if there is a covenant to sink a pit or shaft then the lessee would be bound to do so.

Another matter to be considered in connection with the working of mines is as to preserving support for the surface or enabling it to be withdrawn, and as to these proper provision has to be made in the lease and likewise as to fencing pits, and as to compensation for damage to crops, both as well through carrying minerals over or depositing rubbish upon the surface, as for damage or other inconvenience resulting from smoke issuing from the furnaces used in the workings. As apart from the surface, provision has to be made for the mine receiving support, and as to the avoidance of dangerous

gases, and that the mine shall not be worked in such a way as to cause the mine to be drowned.

As to the repairing and keeping in repair of a mine, the lessee usually undertakes these duties There would appear, however, to be some difficulty as to compelling performance of a covenant as to repairs, for specific performance of it could not be enforced nor could an injunction issue. When a mine is to be worked in a proper and workmanlike manner this means that the mineral must be obtained in an ordinary and workmanlike way.

The repairs which have to be undertaken generally comprise in the case of a coal mine, the agents and workmen's houses, coke ovens, engine-houses and other buildings, railways, wagon ways, and other roads and ways, and the machinery erected and used thereon. The lessee of a colliery, therefore, will agree to repair, fence, dress, cut, scour, cleanse, keep from weeds and in good order and condition and proper working order all the premises which are leased, and all hedges, fences, pales, gates, and stiles, roads, drains and ditches, water-courses and sluices. Buildings, machinery or engines erected on one part of the premises, could, if permitted, by the terms of the lease be pulled down and re-erected on another part, and new engines, machinery and implements could be substituted.

With regard to the right of outstroke previously explained, it should be mentioned that this does not necessarily go to the lessee of a mine unless there is an express stipulation. The lessee is, however, usually permitted to use the demised mine in order to ventilate an adjoining one, but an air-leave rent can be asked if desired. A demised mine can receive the drainage of an adjoining one, if this is due to the natural action of gravitation, and conduits or channels may be made, though not artificially, in such adjoining mine, but water-leave rent may have to be paid in such cases. Water from an adjoining mine may not be artificially conducted into the demised mine.

When there is any likelihood of a mine being worked out, prior to the termination of a lease, provision should be made that all pits and shafts should be filled up by the lessee and the surface restored; but should the mine not be worked out prior to the termination of the lease, then it is usually stipulated that it ought to be delivered up in a condition favourable to the continuance of the working. It is also sometimes required that prior to such determination of a lease, barriers against air and water should be put up by the lessee.

Fixtures and movable effects in and about a mine are generally arranged to be delivered up at the expiration of the lease and, of course, until that time must be kept in proper repair.

In connection with the working of mines, therefore, lessees it may be assumed will agree that the mines shall be worked, managed, and carried on in a fair, proper, and orderly manner, and according to the best and most improved method of working, and so as to obtain the largest quantity of mineral. No act must be done to cause the drowning or firing of the mines or any loss of mineral, or which may occasion or bring any creep or thrust upon the same, or stop or obstruct any of the air-courses, water-courses, passages or drifts thereof. It is sometimes provided that any barrier, bulk, or warren of coal which may be unwrought may be subject to rent as if worked. The working of a mine has to be done without any unnecessary waste and with as little damage to the surface or the buildings thereon as is reasonably possible. The mines have, it is also generally stipulated, to be well drained and ventilated, and pumping shafts and water hods lined with stone or bricks, and all pits and shafts securely fenced. There has to be considered in connection with the working of a mine the sinking, re-erecting, making, and maintaining of all necessary or proper pits, shafts, galleries, levels, adits, buildings, engines, machinery, tackle, and gear, and the provision and employment of proper and sufficient horses, cattle, carriages, tools, utensils, and materials, in order that the works may be followed up skilfully. Pits or shafts sunk, which by reason of the exhaustion of the veins or seams of coal have become useless, have to be filled up or arched over, burying in them the spoil or rubbish which has been raised out of the pit. Roads which have become unnecessary by the disuse of the mines have to be broken up and levelled. The sites of any erections, buildings, engines, furnaces, machinery, ironwork, or other apparatus have to be broken and levelled, when the machinery, apparatus, &c., has become unnecessary.

Amongst the ways in which an end is put to a lease or demise is by forfeiture through some breach of the covenants, or through the period expiring during which the premises are leased, or by cancellation of the instrument of demise; or by surrender of the term or by merger; or by a proper notice to quit. If a notice to quit is given it is better to have it in writing than verbally, and the agent should have authority to give such a notice, and if sent by post the receipt of it should be acknowledged.

(*To be continued.*)

EASY LESSONS ON

MINE VENTILATION.

By J. CARTER, First-Class Certificated Manager.

(COMMENCED IN No. 9, VOL. III.)

SPLITTING OF AIR-CURRENTS.—Continued.

THE following examples are given to make more clear the rules for reducing a number of uneven splits to one uniform airway, of such size as will offer the same resistance when passing the same amount of air, or with the same pressure will pass an equal amount of air.

EXAMPLE.—Reduce the following three uneven splits to one road of 7 feet square, so that it will offer the same resistance with the same quantity of air as the three uneven splits:—

Airway.		sq. ft.		sq. ft.
No. 1	Area	40	Rubbing surface	60000
No. 2	"	35	" "	55000
No. 3	"	30	" "	68000

Let A = Area of new road
a = Area of each split
S = Rubbing surface of new road
s = Rubbing surface of each split
r = Relative quantities
p = Perimeter

$$\text{Rule—}\quad \frac{\left(\frac{1}{r}\right)^2 \times A}{\left(\frac{1}{A}\right)^2} = S$$

First of all apply this rule to find the relative quantities:—

$$\frac{1}{\sqrt{\dfrac{\left(\frac{1}{a}\right)^2 \times S}{a}}}$$

$$\text{No.1} = \frac{1}{\sqrt{\dfrac{\left(\frac{1}{40}\right)^2 \times 60000}{40}}} = \frac{1}{\sqrt{3\cdot75}} = \cdot516528$$

$$\text{No.2} = \frac{1}{\sqrt{\dfrac{\left(\frac{1}{35}\right)^2 \times 55000}{35}}} = \cdot883002$$

$$\text{No.3} = \frac{1}{\sqrt{\dfrac{\left(\frac{1}{30}\right)^2 \times 68000}{30}}} = \cdot630795$$

$$2\cdot030325$$

$$\text{Rule,}\quad \frac{\left(\frac{1}{r}\right)^2 \times A}{\left(\frac{1}{A}\right)^2} = S \text{ of typical road}$$

$$\text{Length of same} = \frac{S}{p}$$

$$\therefore S = \frac{\left(\frac{1}{2\cdot030325}\right)^2 \times 49}{\left(\frac{1}{49}\right)^2} = 23023 \text{ sq. ft.}$$

$$\text{Length of same} = \frac{23023}{28} = 822\cdot25 \text{ feet.}$$

We see here that a road, 7 feet square, and rubbing surface 27709 square feet, will be equal, that is, it will only offer the same resistance as the three uneven roads to pass the same quantity of air with the same pressure. However, as this class of calculations may be difficult for some of the younger readers to grasp I will give an illustration of this rule, and take four uneven splits, all subject to one common pressure.

EXAMPLE.—Find the rubbing surface (S) of an uniform road, 9 feet square, that will offer the same resistance as the four following splits with the same quantity of air passing:—

Airway.	Feet.	Area in ft.	Length in ft.	Rubbing Surfaces.
No. 1	7×4	28	2000	44000
No. 2	6×6	36	1500	36000
No. 3	5×3	15	1600	16000
No. 4	8×3	24	1200	26400

To find the relative quantities apply the rule as previously given:—

$$\text{No. 1,}\ r = \frac{1}{\sqrt{\dfrac{\left(\frac{1}{28}\right)^2 \times 44000}{28}}} = \cdot59552$$

No. 2. $r = \sqrt{\dfrac{\left(\frac{1}{36}\right)^2 \times 36000}{36}}$ $= 1{\cdot}13843$

$\dfrac{1}{}$ (numerator 1 above each root)

No. 3. $r = \sqrt{\dfrac{\left(\frac{1}{15}\right)^2 \times 16000}{15}}$ $= {\cdot}45997$

No. 4. $r = \dfrac{\left(\frac{1}{24}\right)^2 \times 26400}{24}$ $= {\cdot}72223$

$2{\cdot}91615$

$$S = \frac{\left(\frac{1}{r}\right)^2 \times A}{\left(\frac{1}{A}\right)^2} = \frac{\left(\frac{1}{2{\cdot}91615}\right)^2 \times 81}{\left(\frac{1}{81}\right)^2} =$$

77720 rubbing surface.

$$L = \frac{77720}{81} = 959{\cdot}5 \text{ ft.}$$

We will now consider how to find the power or pressure required to pass a given quantity of air, or how to find what quantity of air will pass from a given pressure or power. Quantities that will pass in each split in a mine where there are a number of unequal splits or equal splits are in proportion to the rule as previously shown, or we may find the pressure (p) in each airway to pass the same quantity in each split, and then the proportion will be according to $\dfrac{1}{\sqrt{p}}$

With the same quantity of air passing through airways of different sizes the relative powers or pressures may be found by the following formulæ:— $\dfrac{S\left(\frac{1}{a}\right)^2}{a}$ or $S\left(\frac{1}{a}\right)^3$

EXAMPLE.—Say we have two shafts, downcast and upcast, whose depths are 600 feet. Diameter of downcast, 11 feet; area, 95·033. Diameter of upcast, 12 feet; area, 113·097. We have 50000 cubic feet of air passing, find the quantity that will pass in each of the following splits, and the pressure required to send that quantity; also find pressure in the shafts ?

The quantity of air that will pass in each split of a mine, each being subject to one common pressure, will be in proportion to the formulæ previously given.

The following are the dimensions of the splits, four in number:—

Split.		sq. ft.			sq. ft.
No. 1	Area	28	Rubbing surface		44000
No. 2	,,	36	,,	,,	36000
No. 3	,,	15	,,	,,	16000
No. 4	,,		,,	,,	26400

First we will find the pressure in the shafts:—

D'cast $p = \dfrac{{\cdot}0217 \times 22619{\cdot}4 \times {\cdot}195364}{113{\cdot}097} = {\cdot}8478$

Upcast $p = \dfrac{{\cdot}0217 \times 20734{\cdot}2 \times {\cdot}309136}{95{\cdot}033} = 1{\cdot}4634$

In the case of the splits we must first find the relative pressures by the following rule:— $\dfrac{\left(\frac{1}{a}\right)^2 \times S}{a}$

No. 1, Rel. Pres. $= \dfrac{\left(\frac{1}{28}\right)^2 \times 44000}{28} = 2{\cdot}0027$

No. 2, Rel. Pres. $= \dfrac{\left(\frac{1}{36}\right)^2 \times 36000}{36} = {\cdot}7715$

No. 3, Rel. Pres. $= \dfrac{\left(\frac{1}{15}\right)^2 \times 16000}{15} = 4{\cdot}7406$

No. 4, Rel. Pres. $= \dfrac{\left(\frac{1}{24}\right)^2 \times 26400}{24} = 1{\cdot}9173$

2nd Case.—Find the relative quantities that will pass in each of the above splits, subject to one common pressure. In finding the relative quantities apply the rule as previously given:—

Airway No. 1, Rel. quan. $= \dfrac{1}{\sqrt{\dfrac{\left(\frac{1}{28}\right)^2 \times 44000}{28}}} = {\cdot}70661$

Airway No. 2, Rel. quan. $= \dfrac{1}{\sqrt{\dfrac{\left(\frac{1}{36}\right)^2 \times 36000}{36}}} = 1{\cdot}13843$

Airway No. 3, Rel. quan. $= \dfrac{1}{\sqrt{\dfrac{\left(\frac{1}{15}\right)^2 \times 16000}{15}}} = {\cdot}45997$

Airway No. 4, Rel. quan. $= \dfrac{1}{\dfrac{\left(\frac{1}{24}\right)^2 \times 26400}{24}} = {\cdot}72223$

$3{\cdot}02724$

To find the actual quantity we must proportion the sum of the relative quantities with the relative quantities in each split to the actual quantity passing through the mine, thus—

			Actual Quantity.
I., say as 3·02724 :	·70661 ::	50000 :	11671
II. " " :	1·13843 ::	" :	18803
III. " " :	·45993 ::	" :	7597
IV. " " :	·72223 ::	" :	11929
Total Quantity ...			50000

In order to prove that the above quantities are correct we will now find the pressure in each airway, and should the powers be right then the pressure must be the same in each split. This we shall find to be the case.

$$P = \frac{K\ S\ V^2}{A}$$

No. 1, $P = \frac{\cdot0217 \times 44000 \times \cdot1737}{28} = 5\cdot9 \times 11671 = 68858\cdot9$ units of work.

No. 2, $P = \frac{\cdot0217 \times 36000 \times \cdot2728}{36} = 5\cdot9 \times 18803 = 110937\cdot7$ units of work.

No. 3, $P = \frac{\cdot0217 \times 16000 \times \cdot256}{15} = 5\cdot9 \times 7597 = 44822\cdot3$ units of work.

No. 4, $P = \frac{\cdot0217 \times 26400 \times \cdot2471}{24} = 5\cdot9 \times 11929 = 70381\cdot1$ units of work.

Suppose we wanted to know what quantity of air would pass in each split if the pressure was reduced from 5·9 to 4·5, the following proportion would work out. Quantities vary as the square root of pressures. Therefore—

No. 1	$\sqrt{5\cdot9}$: 11671 ::	$\sqrt{4}$:	9609	cu. feet
No. 2	$\sqrt{5\cdot9}$: 18803 ::	$\sqrt{4}$:	15482	cu. feet
No. 3	$\sqrt{5\cdot9}$: 7597 ::	$\sqrt{4}$:	6255	cu. feet
No. 4	$\sqrt{5\cdot9}$: 11929 ::	$\sqrt{4}$:	9822	cu. feet

Or the following formulæ could be applied to find the quantity:—

$$Q = \sqrt{\frac{P\ A}{K\ S}} = A$$

If we wanted to find the quantity from the power or units of work, then the quantity will be in proportion to the cube roots of the powers or units of work.

Take an example. Suppose with a power of 729000 units of work, 50000 cubic feet of air passing, what amount of air would circulate if it was reduced to 185193 units of work:—

$\sqrt[3]{729000} : 50000 :: \sqrt[3]{185193}$

$= 90 : 50000 :: 57 : 31666\cdot6$ c.ft.

The above examples are given and worked out to show principally the advantages obtained by having airways of good size, because students cannot fail to see that in small airways a good supply of air can only be obtained at a very great sacrifice of power, because the greatest part of the power is expended on friction, and the varying proportion of the power is so much greater than the quantity of air that it becomes expedient to reduce our velocities in mines to a medium in order to obtain a good ventilation with a fair amount of power expended.

(*To be continued.*)

ANSWERS TO COMPETITION QUESTIONS

In No. 19, Vol. III.

MECHANICAL HAULAGE.

(1) A system of mechanical haulage is required in a level, 1800 yards long, to deliver 200 tons of coal in 10 hours to a pit eye, 400 yards below the surface. State generally what arrangements you would prefer for this work?

Answer.—The method of haulage I would adopt in this case would be the endless rope, especially so if the roof is good and will allow two lines of rails and a wide road. The advantages of the endless rope system are, the perfect regularity of the delivery at the shaft bottom—the tubs come one at a time and are easily dealt with—and the full tubs when going down an incline assist in pulling the empty tubs up. With this system the constant attendance of an engineman can be dispensed with by arranging a clutch gear at the bottom of the pit, where the main strap rope terminates. The main rope can be stopped by the men at the bottom of the shaft, who are attaching and detaching tubs, by turning the wheel which disconnects the clutch gear; the engine may continue running.

Most satisfactory results are obtained by employing the slow speed endless rope system and by placing the hauling engine on the surface and carrying the ropes down the shaft. Assuming we employ this system the rope will have to be cleared at the rate of three miles per hour ∴ 1760 × 3 yds. : 1800 : 60 = 20·4 minutes, or $\frac{60}{20\cdot4}$, 2·9 times every hour. Making allowance for stoppages, say 8 hours instead of 10 hours, 200 tons in 8

hours = 25 tons per hour, and 2·9 times = 8·6 tons always on the rope. Each tub will carry 8 cwt., and 8·6 tons = 20·6, or 21 full tubs and 21 empty tubs. The tubs will be attached singly and $\frac{1800}{21} = 85{\cdot}7$ yds. apart. The weight of the empty tubs would be about 3 cwt. To calculate the size of the steel-wire rope it is necessary to find the gravity and friction of the full tubs. We will assume the gradient to be 1 in 10 $\therefore \frac{21 \times 3 + 21 \times 8}{10} =$ 23·1 cwt. gravity. The resistance due to friction (take this at $\frac{1}{30}$th) $= \frac{21 \times 3 + 21 \times 8}{30} =$ 7·21 cwt. friction. We will assume the rope to weigh about 3 lbs. per yard, and judging from the weight just found, viz., $23{\cdot}1 + 7{\cdot}21 = \frac{30{\cdot}22}{20} = 1\frac{1}{2}$ tons. Gravity of rope $= \frac{1\frac{1}{2} \times 1800}{10}$ = 2·5 cwt. Friction of ropes and rollers, which should be about 10 yards apart:—

Ropes $\frac{1800 \times 1\frac{1}{2} \text{ tons}}{30}$ + Rollers $\frac{1800 \times 14\text{lbs.}}{10 \text{ yds.} \times 30}$ = 90 lbs. × 84·2 lbs. = 174·2 lbs. The total forces to be overcome by the engine are 23·1 cwt. + 7·21 cwt. + 2·5 cwt. + 1·6 cwt. = 1·75 tons. To calculate the size of the steel rope required to draw this weight we use the following rule, $C^2 \times {\cdot}45 = 1{\cdot}75$ tons.

$$C = \sqrt{\frac{1{\cdot}75}{{\cdot}45}} = 1{\cdot}9, \text{ or say 2 ins. cir. nearly.}$$

To find size of engine the forces to be overcome are:—(1) Gravity of coal alone, (2) friction of full and empty tubs, (3) friction of rope and rollers:—

(1) Gravity of coal $= \frac{21 \times 8}{10} = 16{\cdot}8$ cwt.

(2) Friction of full and empty tubs =

$$\frac{21 \times 8 + 21 \times 3}{30} = 7{\cdot}21 \text{ cwt.}$$

(3) Friction of rope and rollers =

$$\frac{(3600 \times 3) \times \left(\frac{3600}{10} \times 14 \text{ lbs.}\right)}{30 \times 112} = 4{\cdot}7 \text{ cwt.}$$

The total forces are 16·8 cwt. + 7·21 cwt. + 4·7 cwt. = 28·75 = 3220 lbs. The speed being 3 miles per hour $\frac{1760 \times 3 \times 3}{60} = 264$ ft. per minute.

$$\text{H.P.} = \frac{3220 \times 264}{33000} = 25{\cdot}7, \text{ or say 26 H.P.}$$

We will allow 50% over and above this for general resistances of machinery, therefore, 50% will be half 26 added to it, or 13 = 26 × 13 = 39, total horse-power necessary.

Each cylinder must have $\frac{39}{2} = 19{\cdot}5$ indicated H.P. 19·5 × 33000 foot lbs. per min. = 643,500 foot lbs.

We shall assume mean effective pressure of steam at 30 lbs. per square inch and piston speed at 260 feet per minute.

Area of each piston $= \frac{643500}{30 \times 260} = 82{\cdot}5$ sq. ins.

Dia. of piston $= \sqrt{\frac{82{\cdot}5}{{\cdot}7854}} = 10{\cdot}25''$ say 10″ cyls.

The stroke is generally taken as twice to $2\frac{1}{2}$ times diameter of cylinder. We shall take the stroke in this case to be 2 feet. The revolutions of the engine per minute will be $\frac{260}{2 \times 2} = 65$. The driving pulley for 2-inch rope would be about 8 feet diameter, then 8 × 3·1416 = 25·1328 circumference. The speed of rope being 264, the driving pulley must make $\frac{264}{25\frac{1}{8}} = 10\frac{1}{2}$ revolutions per min. The gearing must, therefore, be 65 to 10·5, or nearly $6\frac{1}{8}$ to 1.

If possible, it would perhaps be better to apply a compound engine and condensing. The ratio of one cylinder to the other in compound engines are generally taken as 1 to 1·5. ∴ 1 : 1·5 :: 10″ = 15″ for low pressure cylinder.

SUMMARY OF ANSWER.—Endless rope system, steel rope 2 inches circumference, and 21 + 21 = 42 full and empty tubs always on the rope, which will be cleared 2·9 times an hour. The tubs will be 85·7 yards apart, empty tubs to weigh 3 cwt. Horizontal compound condensing engine, small cylinder to be 10 inches diameter, geared $6\frac{1}{8}$ to 1, 2 feet stroke, or if the engine be placed at the bottom of the shaft, two cylinders of 10 inches diameter will do, and worked by compressed air.

THOMAS WATSON.

SURVEYING.

(2) What errors in direction are likely to arise in surveys made with the magnetic needle and how can such errors be controlled and corrected ?

Answer.—The errors in direction likely to arise from surveys made by the magnetic needle are caused by not taking into account

the variation of the magnetic meridian from time to time, and by unreliable bearings, due to local attraction, caused by the presence of iron and steel rails, ropes, guides, pulleys, tools, etc., and from the presence of metallic ores in the surrounding strata.

To illustrate the errors likely to arise by the declination or variation of the magnetic meridian we cannot do better than refer to the sad accident in Cornwall, in the year 1893, by which twenty men lost their lives by an inundation of water. On this case being investigated, the inspector for the district found that the accident was wholly due to an error in surveying, owing to not taking into account this variation. In consequence of this the plan of the mine which was being worked in that year was plotted to the 1841 magnetic meridian. Between the 1841 and the 1893 magnetic meridians there was a difference of about 5°30″ hence the plotting of their plans gave them altogether a false position with respect to the old workings, into which they holed with the above lamentable result. In order to control any possible errors from this cause all plans when plotted to magnetic north should be carefully dated, so that the meridian can be altered, or the bearings altered or reduced to the plan meridian.

To control and correct errors caused by local attraction the person making the survey should be most careful to check the survey throughout and prove the work by going on. This is best done by obtaining a true magnetic bearing in some disused road when commencing the survey and using this as a base line. Then if our backsights taken to an object light, placed on the station from whence the foresight was taken, do not give the same reading, the fact proves that some local attraction exists which must be taken into account when taking the next foresight. The work should also be proved by means of tie lines whenever possible to do so. With modern dials the angles can be taken simultaneously with the bearings and used as a check to prove the work.

William Slocombe.

AWARDS

For Answers to Competition Questions.

Question 1.—Thomas Watson, 3, East Hedley Hope, Tow Law.

Question 2.—William Slocombe, 11, Thorne Avenue, Newbridge, *via* Newport, Mon.

Commended.—G. Daykin, J. Stephenson, J. Jones, J. Hardman, T. Banks, J. Davies, T. Smith, E. Hughes, T. Lawrenson, J. Jackson.

CORRESPONDENCE.

Complimentary Correspondence from Certificate Winners.

23, Ellesmere street, Leigh,
September 10th, 1895.

Sir,—I should like to thank you, on behalf of myself, and also your enthusiastic readers, for the generous manner in which you have conducted your Competition. I esteem myself fortunate in getting on the list for your Certificates of Merit, as they have been more of an educationary purpose than the thoughts of getting something. I can only express my thanks and that of your readers in this district, as they say it is the best paper on mining in the market. I wish also that it could be enlarged, and the price increased, as it is really worthy of success, and what is more, deserves it.—Yours faithfully,

JAS. JACKSON.

Butterknowle,
September 5th, 1895.

Sir,—I beg to acknowledge with thanks the receipt of Gold Medal and Certificate. They will, no doubt. be mementos of success, and act as stimulants to aid further progression. The study which was requisite to compete in the competitions was of a most helpful character, thus resulting in enlarging my knowledge of mining. I have never as yet given you my opinion regarding your paper, *Mining*. As for myself I can honestly say that I have received a great benefit from the perusal of the numerous practical articles which have been given from time to time. It is the indispensable mining journal to all mining students, and it is the paper for beginners in the science, and also for practical working miners. When we think of the large number employed in mines, it is obvious that for a mining paper to be successful it must supply something which can be understood and appreciated by the ordinary working miner. My opinion of your paper has not been found by viewing the medal, the foregoing assertion has been my opinion for a considerable time. From experience I have found that papers on mining to be successful must always contain intellectual food for the practical working miner, and I am sure this knowledge is to be found in the paper *Mining*, wishing the paper an increased success.—I remain, yours faithfully,

MYLES BROWN.

Granville Terrace,
Liverpool Road, Hindley,
September 6th, 1895.

Sir,—I received the Certificate of Merit on Sept. 5th, for which I heartily thank you. The more I read your valuable paper, *Mining*, the more I value it. The value of your paper is not in the amount of money and certificates received, but in the knowledge gained.—Yours faithfully,

WILL SUTHERLAND.

24, High Gurney Villa,
Near Bishop Auckland,
September 7th, 1895.

SIR,—I have received the Certificate of Merit which has been awarded to me in the gold medal competition. It is such an excellent and beautiful present that I cannot express in words how to thank you for it, also the valuable learning I obtained whilst competing for it.—I am, yours very truly,

GEORGE DAYKIN.

Greenhill,
Dunaskin,
Ayrshire.

SIR,—My Medal and Certificate came to hand all safe, and I may say that I waited with some anxiety to see what it would be like; and I now say that it far passes my highest expectations. It is a trophy which I will always cherish and be pleased to show to my friends and acquaintances. I have shown it to a few already, and they all pronounce without one exception that it is a beautiful medal, and I ought to be very proud of it. Mr. Editor, I cannot thank you for it as I would like, as words fail me, therefore you must just receive my humble *thanks*. The certificate itself is worth a good deal to me, and I am having it framed and hung up so that others may see it and follow my example in studying *Mining*, for it is a sure road to advance young students. I am myself very much indebted to *Mining* for a great deal of my information. I again thank you, and remain, yours truly,

9th Sept., 1895. THOS. E. AITCHISON.

Ashington,
September 9th, 1895.

SIR,—It gives me pleasure to acknowledge the receipt of a Certificate of Merit, which you have sent to me for work sent to your little valuable paper, of which I am very proud and will take great care; thanking you very much.—I am, yours truly,

JNO. HARRISON.

Murton Colliery,
September 10th, 1895.

SIR,—I have received the Certificate of Merit, advanced stage, which you awarded to me for excellent contributions to your gold medal, etc., competition. The certificate far surpasses what I expected. Without praising you in the least I may say that you deserve great credit for the admirable manner in which it is made up. In my opinion it is equally as good as those issued by the Science and Art Department, and I prize it just as highly. Your paper is getting better with each issue, and I hope that it will continue to do so in the future, and have the success that it deserves. I would like to see you start an article on mechanics or steam, as I think that it is just what is required now that your journal is of a more advanced character. I would suggest that you enlarge your paper to double the size, and make a charge of 2d. per fortnight, I would like to see some of your more able readers than myself give their opinions on the above. Thanking you in anticipation for publishing this letter, I remain, yours &c.,

WM. P. LAWS.

8, Longsight Terrace,
Kinsley Hemsworth,
Near Wakefield,
Sept. 11th, 1895.

SIR,—I am very pleased to inform you that I have received both the Certificate and the Book Prize (Lupton's Mining) awarded for best answers to elementary competition questions given in your valuable journal *Mining*, for which I am truly thankful, and, at the same time, highly satisfied, seeing that the result of the same has exceeded my expectations. I am also pleased to inform you that I have derived a great benefit from the exercise I have had in pondering over the questions given, and from reading the pages of your valuable little paper, seeing that every article is written so plain and simple to understand, and I am sure that every reader must have done the same, especially those who have taken an interest in the competition questions. Great praise, in my opinion, is due for the able manner in which this little paper is carried on, and nothing will give me greater pleasure than to recommend it whenever the opportunity occurs. Wishing your journal the success it so greatly deserves, I remain, yours truly,

JOSEPH WHEATCROFT.

(It gives us the greatest pleasure to know that the Certificates and Prizes have given such satisfaction as is manifested by the above letters. We spared no pains to make the Competition a success, and it is only fair to say the same of those readers who took part in it. For the flattering remarks which many have thought fit to bestow on him, your Editor bows his thanks.)

VENTILATION QUERY.

Will some of your readers kindly answer the following:—

1ST.—What horse-power of a furnace or fan would be required for a ventilation of 150,000 cubic feet of air per minute, with a water gauge of 2·75.

2ND.—Quantity of air circulating in a Mine is 120,000 feet per minute; H.-P. of fan engine is 80, and the useful effect of the fan is 40 per cent., what then should be the height of water-gauge.

WILLIE.

HOW IS A SURVEY PLOTTED.

Sir,—I am struggling to obtain an Under-Manager's Certificate, and although pretty well advanced in mining, I am quite ignorant in Surveying. Would you or some of the many readers of your valuable paper give me a little assistance. I cannot draw any plan to a scale, and this is what I would like to accomplish, and any one instructing me on the following question will oblige:—Plot to a scale of one inch to a chain the following bearings—N. 10 E. 150 links, S. 80 E. 200, S. 40 E. 160, S. 30 W. 260, N. 40 W. 306. Kindly explain what drawing to a scale means, and how by such the lengths are determined.

IGNORANT.

We would advise "Ignorant" to study the series of articles on Surveying which appeared in Vol. II. of "Mining." The necessary information *re* scales will be found in No. 7, Vol. II.—ED.

PUMPING.

Sir,—Would some of the readers kindly answer the following question:—Does a plunger pump more water than a bucket-pump of the same size, and why?

W. WEIR.

THE NATIONAL ASSOCIATION OF COLLIERY MANAGERS.

The annual meeting of the above association was held on the 6th inst., in the Manchester Town Hall, Mr. F. W. T. Brain, the president, occupying the chair. In the report of the council it was stated that their financial position continued to improve, and that favourable arrangements had been made with reference to the question of the insurance of colliery managers —which covered the dangers incidental to rescue work—with the Law, Accident, and Contingent Insurance Society, by which members could secure practically an unfettered policy. A deputation from the council had waited upon the late Home Secretary with reference to proposed mining legislation and laid before him their views on a number of important points. The council had under consideration a scheme for encouraging the younger members by offering prizes for the best papers submitted on selected subjects. The Emergency Committee had had under consideration certain proceedings at coroners' inquests which were considered irregular and contrary to the C.M.R.A., and the matter had been submitted to the solicitor of the association for his opinion thereon. It was announced that the following officers had been elected for the ensuing year:—President, Mr. W. W. Millington, of Hollinwood, near Oldham; vice-presidents, Messrs. F. W. T. Brain, W. H. Chambers, M. Walton Brown, G. J. Binns, Ed. B. Wain, and Isaac Jones; treasurer, Mr. P. Mehers; hon. general secretaries, Messrs. H. Palmer and G. S. Bragge; financial secretary, Mr. W. Saunders.

Mr. MILLINGTON, the new president, then delivered his inaugural address, in the course of which he said his election to the office of president of the society had been to some extent due to a desire to honour the Lancashire branches, and he thanked them, both on that account and for the honour done to him personally. He had always taken a deep interest in the affairs of the association, and was one of its oldest members. He heartily welcomed them that day to the metropolis of the busiest part of the provinces, and was sure they would be interested in the various establishments they were to visit, and especially in that everlasting memorial to the skill of the engineer, and the doggedness and energy of the Lancashire people, which they saw in the Ship Canal. One of the most important events during the year had been the reception by Mr. Asquith of a deputation from their association with regard to the Coal Mines Regulation Bill, and, although the bill had for a time been dropped, their arguments were sure to have an effect on the Government officials. It was only just that when mining legislation was proposed colliery managers and mining engineers should have a voice in the matter. They had great responsibilities, and the tendency of recent legislation had been to unduly increase them. They did not dream of shirking the duties of their position, but they did think it was unfair to go on increasing those responsibilities until they became irksome. It was well known that some of the responsibilities imposed them could not be carried out without causing friction between all concerned. With regard to difficulties with the men, he thought they should settle them when they were mole-hills, and not let them become mountains—the hardships and losses due to the 1893 strike should teach everyone a lesson. He regretted that at present trade was exceptionally depressed, but there was just *now* a silver lining to the cloud, which he hoped would become more apparent. The bad state of trade made their position doubly irksome; they were expected to reduce costs, and they had to try to do it with reduced output. For the colliery manager times were far different now from what they had been in the past, and points had now to be considered which had been formerly ignored. They had to keep the engines and boilers in an efficient condition, and in this connection he thought the ordinary Lancashire boiler the best for a colliery; with proper care it would last 20 years. Then there were the different appliances for the screening of coal, in which so many useful and valuable inventions had been of recent years brought out. Electricity was another important matter which colliery managers would have to consider in future mining operations, and many highly successful plants were in operation in mines for main haulage works and pumping. Coal-getting machines had been in use for many years, worked with compressed air, and he had recently seen an electric plant by which the manager was getting his coal twice or three times as cheaply as by hand. Shot firing in mines was still necessary, but with rigid rules, &c., they had got within measurable of absolute safety. With regard to coal dust, he did not personally agree with those who advocated damping the dust to the point of saturation. Different kinds of sprayers had been introduced, with varying success, and Mr. Saint, who had spent much time in the study of the question, had patented a sprayer which he (Mr. Millington) was almost positive would meet the long-felt want. The coal trade during 1894 had been in a most depressed condition, and yet the output reached 188,277,525 tons, nearly 24,000,000 tons more than in 1893, and 2,798,399 tons above any previous record. Considering the short time colliers had worked during 1894, it was evident that new mines were being developed at a rate much greater than the opening of markets, and it was also evident that men, tempted by short hours and high wages, flocked to the mines whenever there was an opportunity. In 1894, 22,232 more persons were employed in coal mines than in 1893, and 37,257 more than in 1891, when the output was only 2,798,399 tons less than last year. The death rates from accidents in 1894 were slightly worse than in 1893, and loss of life from explosions was 100 per cent. more than in 1893. The Albion Colliery explosion was responsible for 280 out of 317, and, apart from the explosion, there were 37 deaths in different districts. They could not congratulate themselves on this result, as in 1893, apart from the explosion in Yorkshire, where 142 men were killed, there were only 18 deaths. These explosions were a blot on their escutcheon, and with their present scientific knowledge and modern appliances such occurrences ought to be preventable. The Albion Colliery disaster was another deplorable instance of the effects of coal dust of a fiery nature, when, by a sudden disturbance, it was raised into a cloud and came into contact with a strong flame either due to a shot or to a gas explosion. The lesson had not been lost on the members of the association, and he was sure they would do their best to bring about that happy epoch when the columns in the reports of the Inspectors of Mines headed "Explosions from Firedamp or Coal Dust" would be blank. In conclusion, he appealed to the members to do their best to augment the membership of the society and bring its advantages before the colliery managers in their various districts.

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[N]o. 23. Vol. III. SATURDAY, OCTOBER 5, 1895. FORTNIGHTLY. ONE PENNY.

CONTENTS.

THE LAW RELATING TO

MINES, MINERALS, & WORKERS.

By T. F. UTTLEY, Manchester,
Author of "Factory and Workshop Inspection," Editor of "Labour Contracts," 4th Edition, &c., &c.

(Specially written for this Journal.)

II.—WORKING THE MINERALS—REPAIRS—NOTICE TO QUIT.

IN connection with the working of mines it is often usual to give a licensee power to search for minerals. By this licence the licensor grants to the licensee exclusive licence and authority to search for tin, copper, lead, and other minerals for a stated period, usually one year in a certain place. The licensee agrees that he will explore the land and search for minerals in a skilful and workmanlike way and pay the licensee a certain part of all money arising from the minerals. Compensation for damage or injury occasioned to the estate, and the crops and cattle, has to be paid by the licensee, the amount being usually fixed by the toller or agent of the licensor. On the expiration of the term of twelve months, if the licensee obtains a company of adventurers, a lease for a period of, perhaps, twenty-one years may be granted by the licensor to such of the adventurers as he choses to nominate.

When the working is to be that of a tin, copper, or lead mine, the lessor in his lease gives the lessee power and authority to work for those ores and metals, and for other minerals under certain land. The power includes raising and bringing the minerals, and then to spall, stamp, and make them fit for sale. Liberty is also given to dig and make any adits, drifts, shafts, pits, leats, or other conveniences, and the lessee can erect any houses, sheds, engines, or other machines and buildings. He can likewise make wagon roads or railroads or other roads which may be necessary for carrying away the ores or materials. Stone, sand, brickearth or clay are usually allowed to be raised for the erection of buildings, any damage to the surface being paid for. The lessor usually reserves to himself all waters and water-courses, and also liberty for himself and his agents to go into the mine to inspect and to dial, examine and measure it, and to examine its state and condition, and the ores, metals and minerals raised in order to see that they are properly spalled and removed fit for sale. The lessor also reserves liberty to make adits or drifts into his own lands or those of others, he repairing them. As a rule the premises are let for a fixed number of years for a certain rent, and in addition a part of the money for which the ores, metals, and minerals are sold, but the lessor may agree either that prior to any such sale the lessee must spall, dress, stamp, and make merchantable the ores, metals, and minerals, no deduction or abatement being made in respect of rates, assessments or taxes, except property tax; or it may be agreed that the ore must be washed, cleansed and made fit for smelting. On the lessee, of course, falls the duty of paying the rent and taxes, except property tax, and he likewise agrees to work

the mines in a proper and workmanlike way. The lessee has to drive and keep forward all adits and levels of the mine, and continue them in their proper directions. The lessor has a right to work lodes and veins in unworked limits and unwrought by the lessee within the space of say two months and after giving due notice. Engines for draining have to be erected and also working engines, and these must be kept in repair, and an option is usually given to the lessor to purchase the engines, machinery, material and tackle within a certain time. The lessee is generally forbidden to mix without permission any of the raised ores, metals, or minerals with those of another mine. The lessor expects to be furnished annually with plans of the mines or works, with names of adventurers, and to be able to examine and take copies of books of accounts relating to the tin, copper, and other ores, metals, and minerals. The lessee is expected to preserve the earth thrown up, and make and keep up fences round the shafts and adits and workings, and leave the shafts effectually sollared, and repair every road, hedge, and gate which may be injured. Compensation has to be paid for damage done to the land or premises, cattle or goods, and, if demanded a certain fixed sum has to be paid to the lessor for any damage done to enclosed or cultivated land during the working and carrying on of the mines, and this sum varies according to the description of the land. The lessee must convey away all water drawn from the mine or the bottoms thereof, or used for dressing ores or other purposes so that it shall not flow into, injure or foul other streams of water or rivulets of the estate, and the lessee has to make all necessary leats, conduits, pipes, and launders. Restrictions are often imposed as to shafts and erections, and as to bringing tin, copper, lead, or other ores, metals or minerals or mining, or other materials, or deads, or rubbish on the land. No homestead, orchard, or garden ground must be injured or damaged. A lessor and his agents can go down into and examine and measure and ascend from all or any of the workings, and use the tackle and other conveniences for that purpose. A power to revoke the foregoing liberties, licenses, and authorities is given to the lessor, if the lessee for two months consecutively discontinues to work or neglects to carry on the mines in the most effectual way or does not observe the conditions. On the other hand the lessees may have power to determine the lease on giving six months notice in writing. All these powers and authorities, it must be understood, are usually contained in a lease, and would not be adopted otherwise as a matter of course.

Where it is a coal mine that is wanted and leased, the lessee as regards his working powers is given power to dig, sink, drive, and make pits, shafts, trenches, graves, drifts, air-courses, water-gates, water-courses, both for working the coals and for draining and ventilating the mines and seams. Liberty and power of outstroke and instroke are also given, and to build coke ovens or furnaces for the manufacture of coke. Surface accommodation, heap room, ground room, and pit room must also be used, and a sufficient way-leave. Railways, wagon-ways and other ways have to be constructed. Among the erections and buildings which can be put up are those of agents and workmen's houses, engines, and engine-houses, workshops, storehouses, granaries, stables, sheds, and others necessary for drawing and raising the coal and water, or for standing of horses and placing materials. There is granted a user of ways, wayleaves, and railways. The rent may be a fixed sum with or without a surface rent, royalties or duty rents. No rent would be paid or accounted for in respect of coals delivered to the lessor, nor for such coals as were used for ordinary colliery purposes. If sufficient coal was not raised in one year for payment of rent the deficiency would have to be made up in succeeding years. A tontale rent is often reserved. Amongst other matters which a lessee agrees to are to leave pillars and walls for support, and not permit other persons to use drifts, outstrokes, water-gate, or air-course; he has to keep the mine effectually drained and free from foul air, and likewise to erect boundary posts and keep correct plans, and the lessor must be allowed to examine and inspect the plans and account. Uniformity of size or gauge of corves, boxes or tubs is also required. At the expiration of the lease or within six months afterwards, the lessee can carry away and remove all coals and minerals on the bank on payment of rent and royalties, and any live and dead stock, and engines, machinery, and materials, unless the lessor asks them to be left for his benefit. In some cases the lessor of a colliery reserves to himself the rights of hunting, hawking, fowling, game shooting, and fishing.

In the working of quarries of limestone under a lease, the lessee obtains power to

quarry and excavate the limestone or limestone rock lying beneath the land, and to crush or burn it into lime, and to sink or make quarries and other excavations, and to erect and repair bridges, quays, kilns, engines, crushing mills, and other machinery. The lessee is entitled to ingress, egress, and regress over the land. The lessor usually reserves to himself any other ores, metals, and minerals (save the limestone and limestone rock) with liberty to work them. The rent is by payment of a fixed sum with a royalty in addition.

Many of the duties a lessee has to perform and benefits which he is entitled to have and enjoy apply equally in the case of all mines and quarries, and it is, therefore, unnecessary to repeat them here in every case.

(To be continued.)

INDICATORS & INDICATOR DIAGRAMS

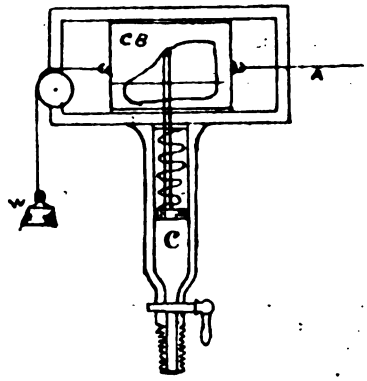
By Jno. W. Nelson, Normanby.

THE Indicator was invented by James Watt. The invention was mentioned in the year 1829 by Mr. Farey, while giving evidence before a Parliamentary Committee.

His object for inventing such an instrument was to determine the amount of plenum or vacuum formed on either side of an engine piston during its motion. Although the construction of the indicator since its invention has been very much improved, yet its principle remains the same, and I have not the least doubt but that Watt with his rude instrument obtained with wonderful accuracy the variation of pressure under his engine cylinder piston.

His instrument simply consisted of a cylinder open at one end to the atmosphere, the other directly connected to the bottom of the engine cylinder. A steam cock between, put the indicator into or out of motion with the engine.

Instead of a pencil on the end of the piston rod, he simply had a pointer to move up and down beside a graduated scale. The sketch is taken from one of an early date, yet it is an improvement upon Watt's. It needs very little explanation. The cord (A) is attached by levers, or by other means, to some moving portion of the engine, usually the cross-head, which gives motion in one direction to the card board (C B), the weight (W) gives the return motion, such motions exactly correspond with that of the engine piston. C is the indicator cylinder showing piston and the piston rod with a spiral spring around it. This spring offers a corresponding resistance to the varying pressure of the steam in the engine cylinder, and the compression of this spring may have been 7 or 8 lbs. to the inch, as Watt had only made use of the atmospheric pressure, but it is necessary to have them to resist 40 or 60 lbs. to the inch of compression for our engines of to-day. Thus for a boiler pressure of 80 or 120 lbs. or more per square inch, we obtain a diagram about two inches high above the atmospheric line.



It is easily understood that such an indicator with a pointer on the piston rod and a graduated scale, or one similar to the sketch, would answer with sufficient accuracy for any engine with such a slow piston speed as that of Watt's engine, but for some of the engines of to-day, that acquire a piston speed of 500 or 900 feet per min., they would be of no use.

To obtain a correct diagram we must intelligently apply an indicator, fitted or constructed to the best perceivable idea, and made as light, as accurate, and with as little friction as possible. The best indicators are Richard's, Crosby's, or Tabor's. It is not necessary to sketch any of these, because almost in every engineering book or journal we find a picture of one or the other.

Referring to Tabor's indicator we find that a light and simple movement is given to the pencil by substituting for one of the parallel motion links a curved slot in a fixed plate. This slot guides a small roller carried by a pencil bar, and ensures a straight line motion to the pencil. It will also be noticed that these indicators are scientifically constructed; instead of the backward and forward motion of the card board we have a piece of smooth paper wrapped around a vertical barrel, it being turned one way with the cord, and the other way by a spring, coiled and attached in the inside of the vertical barrel.

The indicator cylinder is connected to the engine cylinder with a pipe communicating with each end of the steam cylinder; these communications are as short as possible, and immediately under the indicator cylinder is a three-way cock, which enables diagrams from both ends of the engine cylinder to be drawn on one card, and indications of consecutive strokes may thus be obtained. For exact results, however, this method should not be employed, but two instruments should be used, one at each end of the cylinder, the connections being thus shortened. If only one indicator is available, it should be transferred from one end of the cylinder to the other, although this method is open to objection, as the load on the engine may vary while the position of the instrument is being changed.

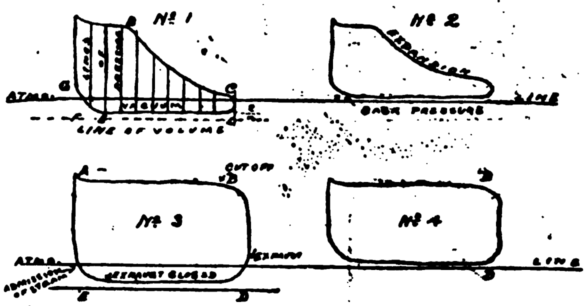
DIAGRAMS.—A diagram obtained by one of these indicators for the up and down stroke of an engine is one continuous line, making a figure very much in the shape of a boot, minus the heel. The area enclosed by this diagram exactly represents the amount of work done on one side of the piston throughout one revolution of the engine. By the shape of the diagram we know how the steam is being applied, whether the opening to steam, or opening to exhaust, or if expansion, release, or compression takes place at the proper time. Further, we are able to detect by this diagram any leaky piston or slide valve, if the steam passages and ports are of insufficient area, or if the amount of lap (either inside or outside), or the setting of the eccentrics require altering.

Watt, in the year 1776, experimented on the expansion of steam, which he produced by an early "cut-off," and right up to this period we have found it more and more economical to raise the boiler pressure and secure as large an amount of expansion as possible by not only expanding the steam in one cylinder, but allowing the steam from the first cylinder to exhaust into a second, third, and even a fourth cylinder, each in succession having a larger piston area. The amount of expansion or the distance to the "cut-off" varies in engines; the boiler pressure and the amount of work the engine has to perform must be taken into consideration.

Engines may work under four different conditions, viz.:—

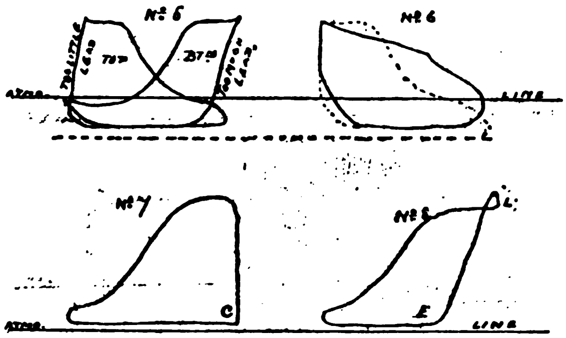
With expansion and with condensation.
" " " without "
Without " " with "
" " " without "

The diagrams sketched are in shape similar to those that engines would produce when working under these four different conditions. The difference of shape is owing to the different pressures throughout the stroke at the same point of stroke in each engine or to the different conditions in which the steam is applied.



No. 1 diagram is the one preferable, it being nearest the desired shape, showing that expansion and condensation has taken place, and that the steam has been used to the best advantage. At G the steam port is fully opened and the steam rushes into the cylinder with a pressure equal to that of the boiler. This pressure is maintained until the steam port is closed at B; then expansion immediately commences and the pressure falls until the exhaust port (c) is opened to the condenser, allowing expansion to continue to, say 10 lbs. below the atmospheric line. The upstroke is now completed, and the downstroke is shown from D to F. At E the exhaust is closed and the steam remaining in the cylinder is compressed until the steam port is again opened from F to G. This compression from E to F tends to bring the piston to rest and so relieve the crank pin of the shock it would otherwise receive owing to the momentum given to the engine and piston. No. 2 diagram is very similar to No. 1, the only difference being that the exhaust side of No. 2 engine piston has a back pressure equal to that of the atmosphere, 15 lbs., while No. 1 has only 5 lbs. back pressure, because 10 lbs. of vacuum was obtained by the condenser. No. 3 works condensively, but not expansively. In practice, when an engine proves too small for its work, it is necessary to maintain the full pressure throughout the entire stroke, at the cost of steam, and to do this the outside lap of the slide valve is chipped off, as in No. 4, likewise in No. 3, but No. 3 having a condenser, the pressure falls from B to D below the atmospheric line.

It will now be understood that indicator diagrams may be obtained of innumerable shapes, as they point out any perfection or imperfection under which the engine is working. As an illustration the diagrams, 5, 6, 7, and 8, may be referred to or compared with Nos. 1 and 2.



No. 5 is of two diagrams, one showing that the slide valve has too little lead and the other too much, or the admission of steam is too late and too soon.

No. 6 shows a leaky valve, that the steam is throttled and that the exhaust is closed too soon.

No. 7. The absence of compression is indicated by the square corner (C) of the diagram, showing that the exhaust is closed only at the end of the stroke.

No. 8. When the exhaust is closed too early on the stroke the enclosed steam may be compressed to a pressure exceeding that of the boiler steam, as indicated at E, the pressure falling again when the steam is admitted, as shown by the vertical drop of the pencil. If the small loop (L) has a flat top, too weak a spring has been used. Dotted lines show the preferred shapes.

To find the I.H.P., divide the diagram into say 10 equal parts, as in sketch No. 1, then read off the pressures at the centre of each division by means of a scale corresponding to the indicator spring, which may be 32 lbs. to the inch. The sum of these pressures divided by 10 gives the mean pressure during one stroke.

Mean pres. × area of piston in sq. inches × stroke in feet × 2 × revolutions per min. ÷ 33000 = I.H.P.

EASY LESSONS ON

MINE VENTILATION.

By J. CARTER, First-Class Certificated Manager.

(Commenced in No. 9, Vol. III.)

Splitting of Air-Currents.—Continued.

Having given a varied number of examples on the splitting of air in mines I will now give a number of miscellaneous examples so as to enable the student to better understand the laws and rules governing mine ventilation, such examples will be given as can be worked out by the previous rules set forth in this journal.

Example 1.—Say we have 36000 cubic feet of air passing through a mine by fan alone, and 18000 cubic feet by furnace alone, find the quantity of air that will circulate with the two powers (fan and furnace) combined.

It has been previously pointed out that the power required to ventilate a mine varies as the cube of the quantity and *vice versa* the quantity varies as the cube roots of the power employed. Take the power of the furnace as 1 to pass 18000 cubic feet of air, then the power required to pass 36000 cubic feet will be according to the cube of the quantities, thus:

$$18000^3 : 36000^3 :: 1 : 8$$

or we may cancel the cyphers and take it thus: $\left(\frac{36}{18}\right)^3 = 2^3 \times 1 = 8$ power required.

Reverse it and say, if it required a power of 8 to send 36000, what power would be required to send 18000 cubic feet of air?

$$\left(\frac{18}{36}\right)^3 = \cdot 5^3 \times 8 = 1 \text{ power required.}$$

In order to find the quantity that will pass with the two powers combined we must add the powers together, thus, 1 + 8 = 9, and as the quantities vary as the cube root of the power we must proceed thus:—

$\sqrt[3]{1} : \sqrt[3]{9} :: 18000 : 37441{\cdot}44$ cu. ft. per min. would circulate when the fan and furnace were at work together.

Example 2.—Take a steam jet and furnace, both acting together in an upcast shaft produce a ventilation of 72000 cubic feet of air per minute. When the furnace is stopped the steam jet alone produces 12000 cubic feet.

If the steam jet were removed and the furnace alone at work, how many cubic feet of air would be produced?

First find the power to produce the whole quantity, 72000 cubic feet. Take the power 1 as producing 12000 cubic feet, the ratio would be as $1^3 : 6^3 :: 1 : 216$, or we may say $12000^3 : 72000^3 :: 1 : 216$, power required to produce the whole; so that if a power of 1 produced 12000 cubic feet of air per min. what will 215 produce?

$$\sqrt[3]{1} : \sqrt[3]{215} :: 12000 : 71889 \text{ cu. ft.}$$

or we can say as:—

$$\sqrt[3]{216} : \sqrt[3]{215} :: 72000 : 71889 \text{ cu. ft.}$$

Therefore we see that the furnace alone would produce 71889 cubic feet of air per minute.

EXAMPLE 3.—Suppose we have two circular airways, each 2000 feet long. The diameter of one is 5 feet, and the other 7 feet. What would be the relative powers to circulate 12000 cubic feet of air per minute through each air-course?

$$\text{Formulæ— } u = \frac{K\ S\ V^2}{A} \times q$$

$$u = \frac{\cdot0217 \times 31416 \times \cdot3733}{19\cdot635} \times 12000 = 155920$$

$$u = \frac{\cdot0217 \times 43982 \times \cdot0973}{38\cdot484} \times 12000 = 19848$$

The proportion of power is $\frac{155920}{19848} = 7\cdot8$ more power required in the smaller than in the larger airway to pass the same quantity of air through each air-course. We can here observe that the following proportion exists between the 5th powers of their diameters, thus: $5^5 : 7^5 :: 1 : 5\cdot37$. This is practically the same as the above, the reason of the difference is due to not carrying the decimal points a little further in the first case.

The above proves the rule that for circular airways to pass the same quantity of air through each the relative powers vary in proportion to the 5th powers of their diameters.

If we wanted to find the quantity of air that would pass through the 7-feet airway with the same amount of power expended in it as in the 4-feet airway, we must remember that the quantity which will pass in circular airways, using the same power, is in inverse proportions to the cube root of the relative power, thus:

$$\sqrt[3]{7\cdot8} \times 12000 =$$

or cube root of powers, thus:

$$\sqrt[3]{19848} : \sqrt[3]{155920} :: 12000 :$$

EXAMPLE 4.—How much more resistance will a current of 800 feet per min. encounter than one of 400 feet in the same airway? The water-gauge in the latter is ·5 inches.

The rule is that the resistance increases as the square of the velocity, so that if we increase from 400 feet to 800 feet per minute, the resistance would be in the following proportion, thus:

$$4^2 : 8^2 :: \cdot5 : 2 \text{ inches of w.g.}$$

$\therefore$ it would meet with $\frac{2}{\cdot5} = 4$ times greater resistance.

EXAMPLE 5.—There are 50000 cubic feet of air passing in a downcast shaft, whose diameter is 15 feet, and the temperature is 65. What must be the diameter of an upcast shaft to pass that quantity of air, the velocity remaining the same and the temperature being 95?

Area of downcast shaft, $15^2 \times \cdot7854 = 176\cdot715$ square feet. To find the velocity we must divide the area by the quantity of air passing, thus:

$$\frac{50000}{176\cdot715} = 282 \text{ feet per min.}$$

As air expands $\frac{1}{459}$ for every degree Fah., the velocity in the upcast would be as below when both shafts are of the same diameter:—

$$282 \times \frac{459 + 95}{459 + 65} = 298$$

velocity in upcast when both shafts are of the same diameter. Therefore if the velocity must be the same in both shafts, then the diameter of the upcast must be as below:—

$$\sqrt{\frac{298 \times 176\cdot715}{282 \times \cdot7854}} = 15\cdot4 \text{ dia. of upcast.}$$

EXAMPLE 6.—If 15000 cubic feet of air pass through an airway, 9 feet by 9 feet, what quantity will pass through if the road were reduced to 5 feet by 5 feet, power remaining the same?

The following rule may be applied:—

$$q = \sqrt[3]{\frac{u}{K\,S}} \times A$$

Therefore we will take the units of work to be 100 to pass the 15000 through the airway in the first instance, then—

$$u \quad \sqrt[3]{\frac{100}{36}} \times 81 : 15000 :: \sqrt[3]{\frac{100}{20}} \times 25$$

$= 1\cdot3 \times 81 : 15000 :: 1\cdot7 \times 25 : 6054$ cubic feet of air would pass through the smaller airway.

EXAMPLE 7.—A mine is ventilated by furnace, the water-gauge of which is 2. If the water-gauge be increased to 3·5, how much more coal would be required ?

The quantity of air varies as the square root of the pressure and the power is obtained by the quantity × by the pressure, consequently, the coal burnt (which equals the power) will be according to the square root of the water-gauge multiplied by the water-gauge :—

$$\frac{\sqrt{3 \cdot 5} \times 3 \cdot 5}{\sqrt{2} \times 2} = 2 \cdot 59 \text{ Ans.}$$

EXAMPLE 8.—Suppose we had a temperature of 60 degrees in the downcast, and the temperature in the upcast being 80, was raised to 200 degrees, what will be the increase in the power of ventilation ?

Here we shall have an increase of power, because in furnace ventilation the quantity of air varies as the square root of the difference between the temperatures of the two shafts. In this case we have a difference in the first instance of 20 degrees between the two shafts. In the second case we have 140 degrees. Therefore, the increase in power would be as follows :—

$$\frac{\sqrt{140}}{\sqrt{20}} = \frac{11 \cdot 83216}{4 \cdot 47213} = 2 \cdot 65 \text{ more coal burnt.}$$

(*To be continued.*)

COMPETITION QUESTIONS.

We make an uniform award of 2s. 6d. to the sender of the best answer to each of the questions given. Answers to be as brief as possible, and sketches must be made when necessary. One or all of the questions may be answered.

Envelopes to be marked "COMPETITION," and to reach us before October 18th, 1895.

We invite readers to forward questions for this competition.

(1) The level course of a bearing is exactly E and W. and the dips due S 1 in 4. A road is started away at 1 in 8, find its bearing. How often do you consider it necessary to check meridian lines ?

(2) How would you extinguish a raging fire in the main intake airway half a mile from the downcast, there being a clear way to the fire. Assuming that there are 50 men working beyond the fire, explain how you would endeavour to get them out as soon as possible ?

(3) How would you put up a safety door, or a reserve door, to be available directly after a severe explosion had happened. What in your opinion is the best method of fixing doors, having regard to a possible explosion ?

THE ENGINEERING OF COLLIERIES

Being a Treatise on Colliery Machinery, Appliances, and Constructions.

By T. A. O'DONAHUE.

(Commenced in No. 9, Vol. III.)

WINDING.—CONTINUED.

CAGE CATCHES.—It is difficult for the engineman to stop the engine to such a nicety that the cages will be exactly on a level with the landing, and catches or keps are usually employed to support the cage while decking. The usual form of keps in use is shown by figs. 40 and 41, and consists of four legs which are pivoted on a shaft to which is also attached a lever. By a movement of the lever handle the catches may be moved into the inclined position shown by fig. 40, when they are required to support the cage, or may be drawn back into a vertical position to allow the cage to descend. The appliance may be worked by either one of the handles shown, the lever connection actuating the other one. In the instance illustrated this connection is situated above the bank level, and although it is more usual to have it situated under, the writer considers this the better arrangement. The keps shown are fitted at a colliery where each loaded cage weighs about 6 tons, and the whole is so well balanced that it requires the slightest power to actuate the levers. The dimensions of the legs at the top are 4 inches × 2½ inches, the length 5 feet 2 inches, and the shafting is 5 inches diameter.

There is a serious objection to this form of keps, namely, that the engine must be reversed and the cage raised slightly before the keps can be withdrawn to allow the cage to descend, and as each reversal consumes steam and takes time, especially if there are several decks, many managers prefer to dispense with catches altogether. It is very doubtful if this is a wise policy as little if any time is saved, and as the cage is often stopped a few inches from its proper position, considerable difficulty is experienced in changing the tubs. One advantage, however, is that the winding rope and capping does not receive the strain at starting. Several ingenious catches, more or less effective, have been designed with a view to obviate the necessity of reversing the engine.

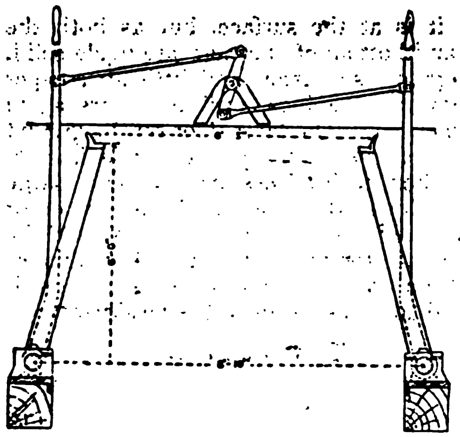


Fig. 40.

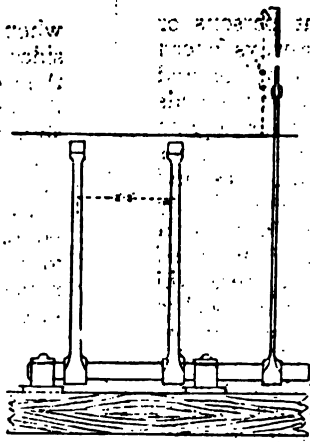


Fig. 4

The majority of these are too complicated and elaborate for practical work, but a few have been successfully employed, the best of which is perhaps the *Stauss* keps. These are simple in working, have no delicate parts to get out of order, and appear to give entire satisfaction, several having been fitted up in this country. They are fixed in a somewhat similar manner as the ordinary keps previously illustrated, there being four catches for each cage, but instead of consisting of legs, small catches are employed which can be extended for the support of the cage, or withdrawn out of the way for its descent at the will of the banksman. Fig. 42 shows one of the catches in position for supporting the cage, the cage resting on the projecting piece A, and fig. 43

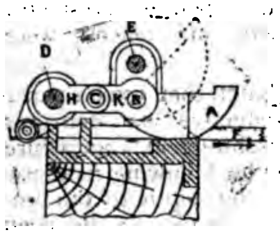


Fig. 42.

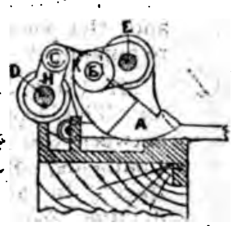


Fig. 43.

shows the position which the catch takes while the cage is in descent. The construction and *modus operandi* is as follows:—D and E are two shaftings which are permanently fixed in one position. On the shafting (D) works a toggle joint lever, one arm (L) of which is connected to a movable link (F), and the link (K) works loosely on the shaft (B). Another link joins the shafting (B to E). The catch (A) works loosely on the shaft (B). We have now practically two fixed shaftings (D & E) and a movable shafting (B). When the cage is ascending A is in the position shown by fig. 42, but being fixed loosely at B, the cage strikes it on passing upwards, and it assumes the position shown by the dotted lines. Immediately the cage has passed, however, it resumes its original position, falling back by reason of its weight on the inclined supporting piece. The cage now drops on to A and is supported by it. From the construction of the catch (A), and resting on an inclined surface, it naturally follows that if the cage rests on the supporting end there will be a tendency for the shaft B to move in the direction of B E, but so long as the links remain in the position shown B cannot move, so that the catch remains unmovable and the cage is supported. When it is required to lower the cage a slight movement is given to the lever (F) in the direction shown by the arrow, this draws in the arm (L) of the toggle joint lever, and the point C is raised a little; immediately the rigidity of the straight line connection between the two pieces (H and K) is broken, the point B is free to move, and the weight of the cage pressing on A completes the remainder of the operation, and pushes it into the position shown by fig. 43. It will be seen that the catch is so constructed that no matter what weight there may be upon A, it is unmovable so long as nothing disturbs the rigidity of the two links H and K, but a very little power applied in the proper direction is sufficient to break the straight line, after which the weight of the cage works the appliance. In order to prevent a strain on the winding rope and capping when the catch is withdrawn, it is necessary to have the ropes most accurately adjusted so that there will be no slack rope, and the weight of the cage will be taken up by the rope immediately. The writer is given to understand that at Llanbradack Colliery, South Wales, where these keps have been employed, they have been made altogether automatic, the link (F) being moved by the tubs at the proper moment after changing. The cost of the Stauss keps is no more than that of the ordinary kind, and as their construction is simple and strong and the work satisfactory, there is every probability of their becoming generally used.

SHAFT-FENCES.—To prevent persons or tubs falling down the shaft it is always fenced off. The fencing is usually made of iron and is fixed permanently at the sides, at the ends however, it is necessary to have gates to gain access to the cages. The best form of gates are those which slide on vertical guides, and which are raised or lowered automatically by the cage. The gate fence is made as light as possible, only a few iron bars being used in its construction, in order that there will not be a heavy shock when it is allowed to drop suddenly—for the same reason rubber rings are placed at the bottom of the guides for the gate to drop on. Sometimes balance weights are also fitted to the gates (fig. 44), and their motion is made much easier thereby. When such fences are placed at intermediate hanging-on mouthings in the shaft, they are

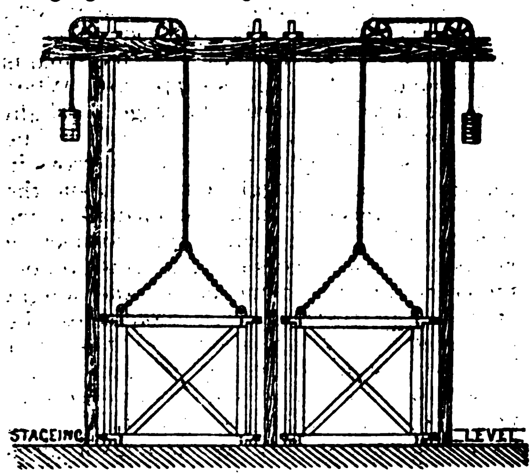


Fig. 44.

always counter-balanced by weights as they have to be raised and lowered by the workmen. If coals and men are wound at a fan shaft, it is not only necessary to fence it at the surface, but it must be entirely sealed up so as to render it airtight, that is, comparatively speaking, to prevent loss of air. That which appears to be the best method of doing this, and the one now generally adopted, is to form a casing of timber from the surface of the ground to the top of the head-gear, which will just enclose the cages and guides. The only openings left in this casing is one large door on the ground level and four small doors at the banking level, one at each end of the two cages. The latter doors are placed inside the casing, and are made the width of the cage and about 5 feet high, and work in vertical slides or on guides similar to the ordinary gate fence. The cage lifts the doors when it is at the surface, but as both the sides and bottom of the cage are made solid, the cage forms a piston and little air escapes through the openings until the doors again shut them up. The large door on the ground level is of the ordinary make, and is only used when it is necessary to send large objects down the shaft such as timber or ponies. The casing and doors should be formed of tongued and grooved timber, nailed on to suitable framework, which is fastened to cross-pieces in the head-gear.

(*To be continued.*)

THE FEDERATED INSTITUTE OF MINING ENGINEERS.

The annual meeting of this institution commenced on Sept. 18th, at Shelton, the president, Mr. W. N. ATKINSON, occupying the chair.

Mr. M. W. BROWN, the secretary, read the report of the council, which gave an account of the work done and the progress of the institution—the number of members for the year 94-95 being 2,199 with 109 non-federated members. The PRESIDENT said it was a fair record of work done during the year and moved its adoption, which was carried.

Mr. G. A. MITCHELL, of the Mining Institute of Scotland, was appointed president, and the vice-presidents and officers were re-appointed.

Mr. CHAS. E. DE RANCE then read a paper on "The Depth to Productive Coal Measures between the Warwickshire and Lancashire Coalfields," of which the following is an extract:—In calculating the depth to the productive coal measures, thanks to the deep borings at Liverpool for the purposes of water supply, and in search of coal and other minerals in Northwich, by the Salt Union, Ltd., the knowledge of the thickness of the triassic rocks is complete. The latter borings probably commenced about 400 feet below the base of the lias, and through the courtesy of the company the writer carefully watched the progress of the work, and made typical collections of the cores for the Museum of Practical Geology, London; the Owens College Museum, Manchester; and the Brunner Salt Museum, Northwich. The following is an abstract of the measures passed through:—

Strata.	Depth. ft.	in.	Thickness of Strata. ft.	in.	ft.	in.
Glacial drift	31	9 ...	31	9 ...	31	9
Keuper marls with rock-salt	412	2 ...	382	5 ...	—	
Keuper marls with gypsum	1,078	10 ...	664	8 ...	—	
Keuper or upper sandy marls	1,293	9 ...	211	11 ...	—	
Upper Keuper sandstone.................	1,469	4 ...	175	7 ...	—	
Keuper or lower sandy marls	1,795	8 ...	326	4 ...	—	
					1763	11
Water stones (Keuper)	2,022	1 ...	226	5 ...	—	
Frodsham beds (Keuper)	2,190	4 ...	188	3 ..	—	
Basement beds (Keuper)	2,504	3 ...	313	10 ...	—	
					708	6
Upper mottled sandstone, Bunter	2,610	4 ...	106	2 ...	—	

Estimating the very least probable thickness of the beds beneath, no less than 1,300 feet would have had to have been traversed by the boring to have reached the carboniferous rocks, or a total depth from the surface of 3,810 feet, or 1,060 feet deeper than might have been expected, from the facts and information known before the commencement of the experiment. Looking to the effect of pressure and high temperature, the low prices ruling of coal, which without an extraordinary expansion of trade, which there is no reason to anticipate, will remain at their present figure until the coal supply becomes scarce, the depth of 3,810 feet will render the new red plain of Cheshire unremunerative, even if no other measures intervene, and other circumstances are favourable. But there is every reason to believe that a thick series of purple marls and red sandstones, without coals of commercial importance overlie the productive coal measures, to the south of the old barrier indicated by Dr. Hull, these measures being considered by him as of permian age deposited in a separate basin to the fossiliferous permian beds of the Mersey basin, but recent trials in various directions in the midland counties point to these beds being really referable to the upper portion of the carboniferous formation, and to belong to that portion of the upper coal measures which lies above the *Spirorbis* limestone, and is not less than 1,200 feet in vertical extent.

The SECRETARY read a paper by Bergassessor Winkhaus, on "The Blasting Efficiency of Explosives," and a paper was contributed by Mr. E. Thompson, from which we have taken extracts, on "The Use of Steel Girders in Mines":—An instance of the advantageous substitution of steel for timber is found in the present extensive use of steel girders in engineering structure where timber beams were formerly employed. Although the conditions of the use of girders in mines differ very considerably from their use in building construction, yet the various properties of steel, its strength and durability, enable a girder to show equally satisfactory comparative results when used there for supporting the roof, as when used for any other purpose. As an instance of the difference in the working conditions to be met with in a mine, it may be mentioned that the weight to be supported in some places is not only unknown but practically irresistible, and the strain is further complicated by pressures both from the top and the sides. Instead of being regular and uniform, the load is varied, and in cases increases with sudden and tremendous force. In addition to these strains, earth movements occur, which tend to displace the supports of the beam, and tend to allow the framework to collapse. Heavy falls of roof also occur on the breaking of the beam, involving heavy costs in clearing away, and by the inconvenience of the delay caused by the obstruction. In such cases the strength, durability, and ductility of a steel girder, as compared with a timber, are seen to great advantage. They carry heavier loads, the safe dead load of an iron girder being one-fourth of its breaking load, to one-fifth of the breaking load in the case of timber. Steel girders seldom break under sudden weights, and by bending give indications of pressure, and an opportunity of relieving it. As a proof of their ductility a Bessemer steel girder, 5 inches in depth by 4 inches in breadth of flange, weighing 22 lbs. per foot, with the weight applied at the centre, took a permanent set of $\frac{13}{16}$ inch, under a load of 14 tons, and showed a deflection of 7 inches under a load of 17 tons without breaking, and instances of greater deflection have occurred in practice. It may be mentioned that in the mine where girders were placed here and there amongst timber bars, the latter have been broken while the girders remained uninjured. If not too much bent, girders can be reset, crown upwards, or can be straightened for resetting, at a moderate cost, and are but slightly impaired by the process. These severe conditions do not exist everywhere; there are many roads in mines where the weight may be taken as fairly uniform, an approximate estimate formed as to the strength of the beam required, and a suitable girder can be selected, so as to obtain the best results. The sections of girders in general use in main roads are as follows:—

Depth of girder.	Width of flange.	Thickness of web.	Weight per foot.	Estimated safe dead distributed load for an 8 ft. span.
Ins.	Ins.	Ins.	lbs.	Tons.
5	4	$\frac{3}{8}$	$16\frac{3}{4}$	7
5	4	$\frac{1}{2}$	22	9
6	$4\frac{1}{2}$	$\frac{1}{2}$	24	12

The safe loads are calculated at one-third of the breaking weight of the girders. On account of the varying conditions of mines it is impossible to give a table of fixed minimum and maximum length at which the various sections may be safely used. In some instances a 9 feet girder (for an 8 feet span), of the lightest section, is used in the place of larch timber, 9 inches in diameter. In others (taking the same span) a section weighing 22 lbs. per foot is required in the place of larch 10 inches in diameter. The heaviest section in other cases has to be used as a substitute for heavier timber. Under comparatively equal loads the various sections of girders may be used as follows:—

Weight per foot.	Length of bars.
lbs.	ft. ft.
$16\frac{3}{4}$	6 to 8
22	8 to 10
24	10 to 14

Where weights come on suddenly and with great force it is safer to use the heaviest section, and in exceptionally heavy parts of a road the girders may be spaced more closely together. In wider spaces, where a central support can be used, the strength of a girder is doubled by adopting their use. The relative costs are easily ascertained at any time, being dependent upon the fluctuations of the steel and timber markets. At the present time, estimating the girders at £5 per ton, these sections cost respectively 9d., 1s., and 1s. 1d. per foot. Comparing these prices with best larch timber, the cost of girders is very little in excess of timber, and if the cost of cutting and trimming the timber be included, with an allowance for waste, steel girders will probably be found to cost less per foot, and in addition prove much stronger. Steel girders are also more easily handled, and cost less to set in position. A larch bar 9 inches in diameter and 9 feet long contains 5 cubic feet, and weighs, when dry, 19 lbs. per foot. A larch bar 10 inches in diameter and 9 feet long, contains $6\frac{1}{4}$ cu. feet, and weighs $24\frac{1}{2}$lbs. per foot. At 1s. 3d. per cubic foot these bars cost respectively 6s. 3d. and 7s. $9\frac{1}{2}$d. each, while a 9 feet steel girder of light section costs 6s. 9d., and of medium section costs 9s. A larch bar, 10 inches square and 8 feet span, is calculated to break under a load, placed at its centre, of 17 tons. Girders compare favourably with timber, as they give an additional 4 or 5 inches in the height of a road; they possess greater durability where exposed to moist air, which, in some mines, destroys the timber in a few weeks; and they are equally suited for pit bottoms, main roads, and return ways. Girders intended for use in very wet places may be tarred at a slight cost. They can be drawn and reset many times, where perhaps timber would not be worth the cost of recovery. In the event of fire timber is not only destroyed, but helps to spread its effects, while girders remain intact, and the road in good order. The blocking of the roads caused by floating timber is also avoided should the mine be flooded with water. The methods adopted in the setting of steel girders are similar to those employed in setting timber bars. The most general modes are to insert the ends of the girder into holes cut in the sides of the road, or to support them on walls or wood props. When side pressure has to be met, girders resting on wood props must be wedged at the joint, to prevent the props from being displaced. Another method is to form a shoulder on the girder to form a support for the head of the prop. It is very important to keep the girders upright; where allowed to cant over their utility is considerably lessened. A ready method for maintaining them upright is to place light timber horizontally from girder to girder, the ends of the timber being held between the flanges of the girders. When canting over they tend to split the wood props upon which they rest, owing to the edge of the flange of the girder being forced into the timber. To meet these cases a shoe, made of iron or steel, may be placed upon the under flange of the girder. Its under side forms a cap, and fits on the top of the wood prop. This shoe answers the triple purpose of preventing the canting of girders, the splitting of the wood props, and their being displaced by lateral pressure, or by collision with tubs. Girders are also used as props to support the girder bars, the light section being equal in strength to the timber generally used for that purpose. To secure the girder props, and so form steel settings, various appliances have been introduced, so that in constructing the settings there is no need for cutting or punching of the girders, which would tend to weaken them. The first of these appliances is an iron or steel clip, made in two pieces, one-half of which fits on either side of the bar and prop when set in the required position,

and a bolt passed through the clip securely holds the framework against distortion by any pressure. The ends of the girder being firmly held, it is able to carry nearly double the weight carried by a girder whose ends are loose. Another appliance is a wrought-iron holdfast or band, made in one piece, and placed obliquely over both the girder and prop when set. An iron bolt is passed through the holdfast at the point where the girder rests on the prop and forms a shoulder to prevent its displacement. As the holdfast passes over the top of the girder it has a greater leverage and extra proportionate power in preventing the canting of the girder. A third appliance is an iron or steel chair, in which the end of the girder and the top of the prop are placed, and are held securely against any movement. Steel settings are also constructed in the form of arches, circles, rectangles, or squares, and are capable of resisting enormous pressure, and prove an efficient substitute for brick-arching.

ANSWERS TO COMPETITION QUESTIONS

In No. 20, Vol. III.

No satisfactory answer received to Question 1.

Question 2 has been held over until next issue.—Ed.

AWARDS

For Answers to Competition Questions.

Question 2.—Matthew Mowvley, Rock Terrace, Soothill Lane, Batley, Yorkshire.

Commended.—J. Field, W. Mycock, J. Stephenson, T. Rimmer, H. Hall, T. Banks, S. Davies.

EDITORIAL NOTES.

The prize of half a guinea and the certificate of merit offered for the best Essay on Indicators and Indicator Diagrams has been awarded to J. W. Nelson, Normanby, whose essay will be found in the present issue.

* * *

The annual report on the mineral statistics of the United Kingdom for 1894 has just been published. The total value of the mineral produce for the year was £77,898,938, being an increase of over 7 millions on that of the previous year. The coal output was 188,277,525 tons, valued at £62,730,179, as compared with 164,325,795 tons, valued at £55,809,808 for 1893, or an average price per ton of 6s. 7·48d. for 1894, as compared with 6s. 9·51d. for the previous year. The average price for each country is as follows:—England, 6s. 6·98d.; Wales, 7s. 6·22d.; Scotland, 6s. 6·06d.; Ireland, 8s. 8·28d. The output for England was 138,327,414 tons, for Wales 28,355,953, for Scotland 21,481,554, and for Ireland 112,604. The total quantity left for home consumption during year 1894 was 145,590,095 tons, as compared with 126,837,725 tons in 1893. France imported over 5 million tons from Great Britain. The world's production of coal for the year 1891 was 553,700,000 tons. To this total the United Kingdom contributes 188¼ millions, United States 170, Germany 74, France 25¼, Belgium 19¼, Austria-Hungary 40¼, Russia 7¼, Australia 5, Canada 4, and India, 3.

* * *

Recently the miners of Northumberland have had before them various proposals as to the shortening of the hours of boy labour in mines. In this district, up to the present, the miners have chiefly worked two shifts of 7 to 7¼ hours bank to bank, whilst the boys are doing duty for two shifts by working a 10 hours day. For changing this system three suggestions were put forth and voted upon, viz.:—(1) Three shifts of men and two of boys. (2) Boys' hours to be 9 per day, the question of how to bring this into effect being left for further consideration. (3) The promotion of an Eight Hours Bill by Parliament. All these suggestions were negatived, and finally a resolution was carried by 161 to 55 that none of the suggestions brought forward could be adopted without introducing greater evils than benefits.

CORRESPONDENCE.

Answers to Ventilation Queries.

Sir,—In reply to "Willie," I offer the following solution:—(1st) What horse-power of a furnace or fan would be required for a ventilation of 150,000 cubic feet of air per minute, with a water gauge of 2·75 inches.

$$\text{H.-P.} = \frac{\text{Quantity} \times \text{W. G.} \times 5\cdot2 \text{ lbs. per sq. ft.}}{33,000}$$

$$\text{or } \frac{150,000 \times 2\cdot75 \times 5\cdot2}{33,000} = 65$$

$$\therefore \text{H.-P.} = 65$$

(2nd).—Quantity of air circulating in a mine is 120,000 feet per minute; horse-power of fan engine is 80, and the useful effect of the fan is 40 per cent., what then should be the height of the water gauge.

As only 40 per cent. of the power put into work is utilised, the horse-power of the fan would equal

$$\frac{40 \times 80}{100} = 32$$

$$\therefore \text{W. G.} = \frac{\text{H.-P.} \times 33,000}{\text{Q.} \times 5\cdot2} = \frac{32 \times 33000}{120,000 \times 5\cdot2} = 1\cdot69$$

$$\therefore \text{W. G.} = 1\cdot69 \text{ inches.}$$

A. H. M.

Similar answers by D. Turner (Tredegar).

ANSWER TO CORRESPONDENT.

Student.—Send Essay on when completed. Sorry illness has hindered you in the Competitions.

Printed by the Proprietors, Strowger & Son, Clarence Works, Wigan, and published by Messrs. E. Marlborough & Co., 51, Old Bailey, London, E.C.

MINING

A JOURNAL DEVOTED TO THE INTERESTS OF MINI

o. 24. Vol. III. SATURDAY, OCTOBER 19, 1895. FORTNIGHTLY. ONE PENNY.

CONTENTS.

EASY LESSONS ON

MINE VENTILATION.

By J. CARTER, First-Class Certificated Manager.

(COMMENCED IN No. 9, VOL. III.)

IN ventilation the barometer is used to show the atmospheric pressure and the various changes which occur at times of such pressure with its resultant release of gases (when a fall of pressure takes place) pent up in goaves. Owing to the great pressure that gas is pent up in the coal a diminution of pressure in the atmosphere is only a very small proportion of the total pressure at which the gas exists, therefore, the greatest effect of such diminution of pressure would be in goaves and old places filled with gas. The greatest effect and danger is when sudden changes occur, the depression then is so quick, consequently the expansion of gas is sudden, thereby quickly issuing from the goaves and into the workings of the mine, and at times issue so freely as to cause a withdrawal of men from that portion of the mine, or if not perceived in time the result might prove disastrous. Therefore it is well that any changes in the barometer should be noticed (especially a depression), and goaves should be strictly watched, because gas is more sensitive than mercury and changes can be seen at such places long before any real change has taken place in the barometer. To point this out more clearly I will give examples on the result of such changes. It is important that these changes should be clearly understood, because in the ventilation of a mine they are required if a person must have control of the mine under such conditions.

EXAMPLE.—Suppose we had a goaf filled with gas, say 900 feet long and 1500 feet wide, in a mine whose height is 4 feet 6 ins. What would be the effect of a sudden depression of the atmosphere, say the barometer stood at 30 inches and it was reduced to 29·5 ?

We must first find the cubical contents of the goaf, and as the law of gases and air is such that they expand and contract in proportion to the diminution or increase of pressure ∴ cubical contents of goaf = 900 × 1500 × 4·5 = 6,075,000 cubic feet, then this would expand in the following proportion, thus:—

29·5 : 31 :: 6075000 : 6383898 cu. ft.

We see here that a reduction of 1·5 inches would mean a volume of (6383898—6075000) 30889 cubic feet of gas would issue from the goaf, and this excess would make its way into the workings of the mine, therefore, this points out the importance of carefully watching such places as these and to have a good supply of ventilation.

Air and gases expand by heat and contract by cold according to the following law:—Gases or air expand $\frac{1}{460}$ for every degree Fah. ∴ 520 cubic feet at 60° would become 580 at 120°.

Take an example. Suppose we had 120000 cubic feet of air per minute enter the downcast shaft at a temperature of 60° F. How many cubic feet of air per minute will issue from the upcast shaft with an average temperature of 130° ?

$$\frac{459 + 130 \times 120000}{459 + 60} = 136185 \text{ cu. ft.}$$

How many cubic feet of firedamp are there in 20000 cubic feet of the most explosive mixture?

Take such a mixture of 1 of gas to 9·4 of air to form such proportion, then the quantity of firedamp would be 1923 cubic feet, thus—

$$\frac{20000}{10{\cdot}4} = 1923 \text{ cu. ft.}$$

If an explosive mixture of air and gas at the most explosive point was passing through an airway, 6 feet by 7 feet, at a velocity of 450 feet per minute, what quantity of fresh air must be added to render it so that you cannot perceive it on the flame of the safety lamp?

Area of airway $= 6 \times 7 = 42$

$\therefore$ cu. feet of gas passing $= 42 \times 450 = 18900$.

When a mixture of 1 of gas to 9·4 of air is at its most explosive point then—

$$\begin{array}{l} 10{\cdot}4 : 9{\cdot}4 :: 18900 : 17082{\cdot}7 \\ 10{\cdot}4 : \;\;1 :: 18900 : \;\;1817{\cdot}3 \\ \hline \qquad\qquad\qquad\qquad 18900{\cdot}0 \end{array}$$

Now to find the quantity of air to be added so that the gas cannot be perceived on the flame of a safety lamp it will require 31 of air to 1 of gas. Then $1817{\cdot}3 \times 31 = 56336{\cdot}3$ cubic feet of air required, but of this quantity we have already 17082·7 cubic feet of air in the mixture, therefore it would only require an additional quantity of 39253·6 cubic feet of air per minute, thus—

56336·3—17082·7=39253·6 quantity of air.

It would, therefore, require the above additional quantity of air per minute to dilute the gas so that its pressure could not be perceived on the flame of the safety lamp.

The height of the barometer being given, how do you find the pressure per sq. foot?

The pressure per square inch is found by multiplying the height of the barometer by ·4908 (the weight of a cubic inch of mercury) and then by 144. To find the pressure per square foot when the barometer stands at 30 proceed thus:—

Pres. per sq. in. $= 30 \times {\cdot}4908 = 14{\cdot}724$

" " ft. $= 14{\cdot}724 \times 144 = 2120{\cdot}256$ lbs.

The student may ask, does the atmospheric pressure, as indicated by the barometer, make any difference in the quantity of air passing through a mine? I may say that it has very little or no effect in altering the volume of the air passing in a mine, although it alters the density and weight.

In the ventilation of mines in what way is the thermometer of use?

It is used to obtain the difference between the temperatures of the upcast and downcast shafts, and from this we are enabled to calculate the pressure in ventilation due to the action of the furnace. It may be stated here that an increase of temperature of the outer atmosphere acts against us in mines not having proper means of ventilation.

What is the weight of a cubic foot of air at a temperature of 85 degrees, barometer 29·75 inch?

$$W = \frac{1{\cdot}3253 \times 29{\cdot}75}{459 + 85} = {\cdot}072 \text{ lbs. Ans.}$$

The following are a few questions taken from the various examinations held for mine managers' certificates, first-class:—

(1) You have 140000 cubic feet of air per minute passing through a mine at a temperature of 45 degrees F., the temperature of the return at the bottom of the upcast shaft being 82 degrees F. What is the volume of air circulating per minute in the upcast shaft? Show calculation.

$$\begin{array}{cc} 459 & 459 \\ 45 & 82 \\ \hline 504 & 541 \end{array}$$

$504 : 541 :: 140000 = 150277$

cubic feet per minute in upcast with a temp. of 82 degrees, and downcast 45 degrees.

(2) What horse-power is expended in the ventilation of a mine when the quantity of air passing is 95000 cubic feet per minute and the water-gauge is 3·75?

$$\text{H.P.} = \frac{95000 \times 3{\cdot}75 \times 5{\cdot}2}{33000} = 56{\cdot}13 \text{ H.P.}$$

(3) To what extent will 2000 volumes of gas expand if the barometric pressure fall from 30·15 to 29·30 inches?

$$\frac{30{\cdot}15 \times 2000}{29{\cdot}3} = 2058 \text{ volumes.}$$

(4) What additional ventilating power will be necessary to double the quantity of ventilation without altering the airways?

The power necessary for increasing ventilation varies as the cube of velocity, therefore, in this case, the power required would be 8, because take the velocity as 1, then this

doubled equals 2, and as power varies as cube of velocity the answer will be found thus:—

$$2^3 = 8 \text{ Answer.}$$

(5) If it requires 8 horse-power to circulate 30000 cubic feet of air per minute in a mine, what horse-power will be required to pass 50000 cubic feet through it? Airways to remain in the same condition.

$$30000^3 : 8 :: 50000^3 : 37 \text{ horse-power.}$$

(*To be continued.*)

THE LAW RELATING TO

MINES, MINERALS, & WORKERS.

By T. F. UTTLEY, F.I.I., Manchester,
Author of "Factory and Workshop Inspection." Editor of "Labour Contracts," 4th Edition, &c., &c.

(*Specially written for this Journal.*)

III.—Fixtures.

FIXTURES are things of an accessory character annexed to houses or lands, including not only such things as grates in a house, or steam engines in a colliery, but also windows and palings. To be a fixture a thing must not constitute part of the principle subject, as in the case of walls or floors of a house, but on the other hand it must be in actual union or connection with, and not merely brought into contact with it as in the case of a picture suspended on hooks against a wall.

In its broadest meaning the word "fixture" would comprise anything annexed to the freehold, that is to say fastened to it, or connected with it, and not merely laid on it. In order to encourage commerce many fixtures which would be otherwise irremovable, are considered if set up for mercantile purposes as severable; and, under this rule, would come the large amount of machinery required by manufacturers and traders, *e.g.*, in the case of a colliery the removal of the engines, tramplates, and machinery of every kind erected, fixed and used in the works. Buildings of brick and stone would not be removable unless it was expressly stipulated.

Disputes sometimes arise in the case of fixtures as between the heir and the other personal representatives of a deceased freeholder, and in this case the heir is preferred, or there may be some differences between an executor and a remainderman or reversioner, and here the executor has a better claim, where the fixtures are wholly or in part erected for the furtherance of trade, but the most numerous questions occur as between landlord and tenant, and here more favour is uniformly shown to the tenant. In the case of particular items the rule to be followed as to the legality of the removal of fixtures should be whether they can be removed without occasioning any great damage or injury to the freehold, or be taken away without being entirely destroyed themselves or without losing their value. An entire building of brick would not, therefore, be removable, but where there is merely a brick foundation and the rest of the erection is of wood it might be removable; such articles as steam engines, furnaces, machinery, and stoves could generally be removed.

Where a tenant erects at his own expense, with the landlord's consent in writing, any buildings or machinery for trade purposes, he may remove them, if he puts the land or building into as good a condition as it was before the erection was made, unless the landlord on receipt of a month's notice of the intention to remove the erection, elect to purchase the same at a value to be ascertained by two referees or an umpire.

The tenant's right to remove fixtures may of course be controlled or modified by express stipulation or by local usage.

If a tenant who is possessed of fixtures, which he has a right to remove, does not remove them during the term, they become a gift in law to the landlord, unless the tenant after expiration of the term, is permitted by the landlord to remain in possession, and removes them during his lawful possession. Any injury done by the severance must be repaired.

Where either freeholds or leaseholds having fixtures thereon are mortgaged the fixtures will pass to the mortgagee, and as to the question of whether such a mortgage is within the Bill of Sale Acts and requires to be registered, the rule is that in the case of trade machinery, if it is not specially mentioned in an assignment of the premises, but merely passes as incidental to such assignment, then no registration is necessary. This is now the only way of mortgaging by one instrument, premises and fixtures in the nature of trade machinery for a conditional bill of sale which expressly includes other property not within the Bill of Sale Acts is void as a bill of sale. There is, however, some distinction between trade

and mining fixtures, the former being mixed cases of enjoying the profits of land and carrying on a species of trade, whereas the latter were fixtures, subservient to trade only without any relation to the profits of the land. Machinery, boilers, boiler grates, castings and iron works of engines and regulators, and of spring beams, the valve piping, the cupola, the blast pipes, the puddling furnaces, the mill furnaces, the boilers of the forge engines, the grates of the boilers, and the castings and iron works of the engines, the plates from the shears foundation, the holding down pins and bed plates, the gasometer and apparatus, all these have been held to be removable by a tenant, provided the tenant did as little damage as possible.

A distress for rent can be made on machinery and other fixtures which belong to the owner of the mine.

Various statutory provisions of 1851 and 1883, provide that if any tenant of a farm or lands, shall with the consent in writing of the landlords for the time being at his own cost and expense, erect any farm building, either detached or otherwise, or put up any farm building, engine or machinery either for agricultural purposes, or for the purposes of trade and agriculture (which shall not have been erected or put up in pursuance of some obligation in that behalf), then such buildings etc., shall remain the property of and removable by the tenant so that he does no injury by the removal thereof; but before removal one month's notice shall be given to the landlord, who has the option of purchasing. Since 1893, however, such fixtures may be removed although not effected with the consent in writing of the landlord. Before this the tenant must pay all rent, and in removing must do no avoidable damage, and if in removing he does any damage he must make that good.

When the surface of the soil is held by a person distinct from the owner of the mines, the latter may erect on the surface workshops, engines and other buildings, and every convenience for the efficient working of the mines; and these are fixtures which will become the property of the owner of the surface if abandoned, but until abandoned they can be used by the owner of the mines so long as necessary for working the minerals.

It will be understood that fixtures are *subject* to any express stipulation contained *in instruments affecting* them.

THE ENGINEERING OF COLLIERIES

Being a Treatise on Colliery Machinery, Appliances, and Constructions.

By T. A. O'DONAHUE.

(COMMENCED IN No. 9, VOL. III.)

MODERN CHANGES AND WHY NECESSARY.

IT is doubtful if in any other branch of coal mining has there been such vast improvements in recent years as in banking and screening. It is now most clearly proved that the cost incurred by increased cleaning and classification of the coal is so little compared with the increased commercial value which the coal acquires that modern collieries are most elaborately fitted out with screens and picking belts, and those older collieries which have still a few years existence have found it expedient to re-model and add to their arrangements in many ways. A few years ago 500 tons per day from one shaft was considered excellent, nowadays scarcely any new colliery is fitted up to wind less than 1000 tons per day, and in many cases the quantity much exceeds this amount, notwithstanding the fact of there being greater difficulty in dealing with coal at the surface; instead of being turned directly into a screen, which was little more than a shoot, the coals are placed on screens with very little inclination, which are sufficiently agitated by mechanical means to gently propel the coal forward and to effectually classify it into various sizes, with a minimum of breakage. The wholesale breakage of the coal and consequent depreciation commercially, caused by the rough methods of screening, appears to have escaped attention for a considerable period, but all this is changed for several reasons. The number of transitory stages rendered necessary to make the coal fit for market and the consequent breakage at every stage quickly demonstrated the necessity of careful handling, and accordingly means were devised for reducing the breakage.

Again, the much more stringent restrictions and reservations—and in many cases exorbitant charges of the lessors—combined with the factor of safety, induces managers to have every scrap of coal, even of the smallest and most inferior kind, sent up to bank, so that breakage now shows to a more alarming extent than formerly. Another reason, though perhaps irrevelant to the subject, is the increased competition in the coal as well as in

other industries; it is now only in exceptional cases that collieries have the monopoly of a district.

The increased output per shaft is due to somewhat similar causes as necessitated the alterations in the cleaning of the coal. The cost of fitting up the screening arrangements and other plant is such that it affords a great inducement to get as much work as possible out of each shaft. The royalty leases also include the lower mines with the top ones, and deep shafts are necessary; in other cases the top mines have been won and only the deep ones remain to be got. Another important item is the concentration of the staff and plant in general combined with the increased facilities for transportation underground.

BANKING ARRANGEMENTS.

Before discussing the methods of banking the coal it would be well to call attention to the stages through which the tubs or wagons have to pass, in order that a clear conception may be had of what arrangements are necessary. The loaded tubs are taken from the cage, which comprises one or more decks, to a weighing machine to record the weight of the minerals and the check number of the getter, then to the tippler where the coal is turned on to the screens, the empty tub is then run back to the shaft to be sent down again to the workings. Assuming the tubs to have a capacity of 10 cwt. (the average capacity of the tubs in the Lancashire district will be less than this), and the actual working hours, excluding meal times and occasional stoppages, to be 8 hours—to wind a modern day output, from 2000 to 2500 tubs, or say 300 tubs per hour, or 5 per min., have to pass through the stages described. The winding takes such a considerable portion of the day, comparatively speaking, that only a few seconds are allowed for exchanging the tubs at each wind, and when 300 tubs have to be decked in one hour there must be no impediments about the arrangements. Single-deck cages, capable of holding two or three tubs of the capacity mentioned, are, of course, altogether out of the question for such large outputs, so that cages with two or three and in a few instances four decks are employed. Having cages with several decks leads us to the question of landings. With two decks to each cage, one landing at the surface and one at the mouthing underground, may be deemed sufficient, and with double-decked cages, holding in all six tubs, of say 10 cwt. capacity each, there is no difficulty in obtaining an output of 1000 tons per day when winding from comparatively deep shafts, say 500 yards deep. By this arrangement considerable time is lost in changing the position of the second deck to the landing, but if the work can be managed without difficulty there is a saving in wages, which is of very great consideration, whereas in one case one staff is required, in the other there are two, though it is needless to state that the numbers are by no means doubled in the latter case. When the decks of the cage number three or four, the time taken to change all the decks at one landing would be such as to impede rather than facilitate the banking, though in some instances where the shafts are of great depth and considerable time is taken in winding, a three-decked cage with only one landing stage is considered beneficial.

The writer has frequently timed the winding and decking of coal at various places, and has found that, at a well regulated colliery, and without any special appliances other than those ordinarily in use, it requires on the average about 10 seconds to exchange the tubs from a cage with one deck holding two tubs. With a double-decked cage holding four tubs, and banking each deck separately, the time occupied will be from 18 to 20 seconds, though the same can be done in 10 seconds if the decks are banked simultaneously. With a three-decked cage from 25 to 30 seconds will be required for banking if each deck is changed separately at one landing, and 10 seconds if the decks are banked simultaneously. With reference to the time occupied by the actual winding, much depends upon the depth of the shaft, and in deep shafts very great speeds may be obtained. A shaft 200 yards deep may have an average winding speed of 25 feet per second, and a shaft 500 yards deep 40 feet per second, while one 700 yards deep may have a speed of 50 feet per second. At one particular shaft 720 yards deep, the winding is performed on the average in about 50 seconds, and were it is necessary to increase the output there would be no hesitation in reducing this time by nearly 10 seconds. The cages are double-decked and hold four tubs each, with a total capacity of about 2 tons. The decks are changed separately on one landing, and this occupies about 20 seconds. The engines are horizontal, coupled with 40 inch cylinders, 6 feet stroke, and the drum is parallel 20 feet diameter.

(*To be continued.*)

NOTES ON SURVEYING.*

By T. H. Cockin.

ALTHOUGH during the last twenty-five years very great improvements have been made in almost every branch of mining, the method of making surveys has at the majority of collieries remained unaltered, and it can hardly be argued that this is because there is little room for improvement, as it is admitted on all sides that the system at present in use, depending, as it does, on a variable Magnetic Meridian, has very many defects. The large areas which are now worked from single plants, and the increasing value of our rapidly diminishing coal fields, necessitate accurate plans, since large areas mean long roads, and the longer the road the greater the danger of error, and the amount of coal wasted by inaccurate plans cannot be estimated.

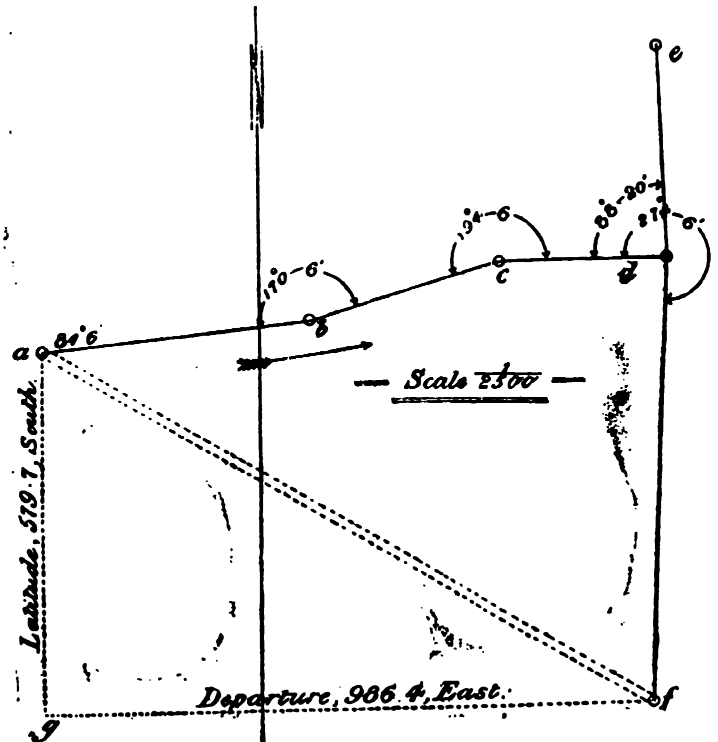


Fig. 1.

There distinct branches of surveying are in daily use about collieries, first, Underground; second, On the surface; and third, Levelling, which is practically the same operation either on the surface or underground.

* *Extract* from Paper in Journal of the "British Society *of Mining* Students."

The system of underground surveying almost universally in use in the Midlands is known as "fast needle dialling," the instrument used being the ordinary dial with vernier reading to 3′. A survey on this system is made as follows:—A place is chosen at one end of the road to be surveyed, as free from all sources of attraction as possible, and the dial is set up and adjusted, N. and S. line on the dial plate being set exactly parallel to the needle, the base of the dial is clamped in this position, and a foresight is taken by the vernier to legs set at the next station B, the dial is then taken from these legs and set on the legs at B, the base screw is slacked, and a back sight taken to A (A being a light set on the legs upon which the dial was fixed in the first instance), the base screw is then clamped and the next foresight is taken with the vernier to C, from C a back sight with the base to B, and foresight with vernier to D, and so on. In this way the dial plate is kept in exactly the same position throughout the whole of the survey, the bearings being read from it by the vernier; and, as the dial plate was set parallel to the needle in the first place, it follows that all the angles read are the actual magnetic bearings.

It will be seen that this system is exceedingly simple, and by it disconnected districts can be located with great ease; but it has many drawbacks: it may be difficult to get sufficient reliable "loose needle" sights (this difficulty is particularly prominent in metal mines), especially in surveys of main roads, on account of rails, ropes, pipes, etc., and apart from this, the Magnetic Meridian has many defects; there is its diurnal movement of 10′, which would make a difference of 23 links per mile; magnetic storms have been known to affect the needle to the extent of 1½°, and its annual deflection of 8′ has always to be dealt with. Another fault in this system is that an error may be carried forward right through the survey and not discovered until the needle is checked at the end; and only one observation is taken at each angle, so one mistake ruins the whole business.

Surveys made in this manner are either plotted with a protractor, or the leading points got by computation. A cardboard or paper protractor with the centre cut out is the handiest, as the bearings may be taken direct from it by a parallel ruler. In some districts an arrangement called a plotting table is used; it is a drawing-board having a large movable centre, around which is a brass circle divided into degrees, etc., like an ordinary protractor; the survey is plotted on paper pinned to the movable centre, which is slewed round to the proper angle, as found by the brass ring, and the bearings ruled off with a T square, the survey is then transferred from the paper to the plan.

In plotting an extensive survey, the position of the principal points should be got by computation, and the details filled in with a protractor.

In surveys made with fast needle the quadrants are often read off, thus 100° ,, 30′ would be booked as S. 79½ E., and so on; the advantage of doing this is not very obvious—it is probably a relic of loose needle dialling. In booking in this way three things have to to be noted: first, the quadrant; second, whether the figures read from right to left, or left to right, as this is changed every quadrant; and third, the number of degrees and parts; the first and second of these are fruitful sources of error which are absent when the figures are read all round the plate. The annual movement of the needle should be dealt with at each survey, either by adding to each bearing, when plotting, the requisite number of minutes, about 8 per annum (here another drawback to the system of booking quadrants shows itself), or the protractor may be set off the North line, a new permanent line being put up on the plan every few years.

The other system upon which underground surveys can be made, and which appears to have many advantages, especially for important surveys of main roads, is by taking, either with a dial or theodolite, the angle each road makes with the next, each road being the base for the next, and so on; there are several methods of booking surveys made in this manner, the one described is as simple as most; all angles taken are to the *left*, and there are no signs used, such as + or —, as in some systems, and each set of angles is absolutely independent.

A survey of the roads shewn in sketch, Fig. 1, would be made and booked as follows:—The road *a b* is already on the plan, and would be the last long sight of a previous survey, plugs being left in roof or floor at *a* and *b*. The dial or theodolite is set up at *b*, a back sight taken to *a*, and the reading of the vernier, whatever it happens to be, is noted and booked as below, in this case it may read 22°—14^{m}; a foresight is then taken to *c*, the vernier of course only being moved, and the reading booked under the reading of the backsight, say it reads 192°—19^{m}, then the angle *a b c* will be 192° ,, 19^{m}—22° ,, 14^{m} = 170° ,, 5^{m}, that is, reading of foresight, minus reading of back sight = angle to left of lines.

It is well to take at least a couple of observations at each station, making the reading of the foresight of one observation the back sight of the next, so the base screw only is loosened, and a back sight taken but not read, as that has already been done; another foresight is then taken with the vernier, this time it reads 2°—25^{m}; subtract back sight as before (as the vernier has passed the 360, this must be added), this time the angle measures 2° ,, 25′—192° ,, 19^{m} = 170° ,, 6^{m}; to settle which of the two is correct another observation would be taken in the same manner. At the junction of two or more roads as at *d*, the angles should be taken one after the other from the same base, and the readings of the back sight, which is underlined, subtracted from each foresight in the same group.

The angles at *b*, *c*, and *d* would be booked as below:—

Angle *a b c* ..	22°—14m		
		170°—5m	
	192°—19m		*a b c*, 170°—6m
		170°—6m	
	2°—25m		
		170°—6m	
	172°—31m		
Angle *b c d* ..	172°—31m		*b c d*, 194°—6m
		194°—6m	
	6°—37m		
		194°—6m	
	200°—43m		
Angles *c d e* and *c d f* ..	200°—43m		
		88°—20m	*cde*, 88°—20m
	289°—3m		
		274°—6m	*cdf*, 274°—6m
	114°—49m		
		88°—21m	
	203°—10m		
		274°—6m	
	28°—55m		
		88°—20m	
	117°—15m		
		274°—7m	
	303°—2m		

A survey made like this might either be plotted with a protractor, making each line the base for the next, but it would be much better to reduce these angles to meridian angles, the meridian being true North. The rule for this is:—Add together the meridian angle of the first line and the angle it makes with the next line, and if the sum be more than 180°, subtract 180 from it, and if less than 180°, add 180 to it. In the example given, suppose the meridian bearing of *a b*, as found from a previous survey, is 84°—6m, the meridian angles of the other lines would be found as follows:—

In line *a b*, N. 84°—6m E., 436.

Cos. 84°—6m = ·1028, and ·1028 × 436 = 44·82 chains. Northing (Lat.)

Sin. 84°—6m = ·9947, and ·9947 × 436 = 433·69 chains. Easting (Dep.)

Therefore, by measuring 44·82 N. from *a*, and then 433·69 E., the exact end of the line will be obtained.

The Latitudes and Departures for the whole survey are calculated as above (but not plotted), those in each quadrant added together, and the differences between Latitudes N. and S. and between Departures E. and W. found and measured off, in this way the exact

		Distance
Line *a b*...	... ...	84°,, 6m...436
,, *b c*...	84°,, 6m + 170°,, 6m = 254°,, 12m & 254°,, 12m—180° =	74°,, 12m...318
,, *c d*...	74°,, 12m + 194°,, 6m = 268°,, 18m & 268°,, 18m—180° =	88°,, 18m...277
,, *d e*...	88°,, 18m + 88°,, 20m = 176°,, 38m & 176°,, 38m + 180° =	356°,, 38m...
,, *d f*...	88°,, 18m + 274°,, 6m = 362°,, 24m & 362°,, 24m—180° =	182°,, 24m...720

These should be reduced to acute angles in order to compute their Latitude and Departure. The lines *a b*, *b c*, and *c d*, being in the first quadrant, will read the same, that is, N. 84°—6m E., N. 74°—12m E., and N. 88°—18m E.; *d e* is in the fourth quadrant, its bearing will be 360°—356°,, 38m = N. 3°,, 22m W. *d f* is in the third quadrant, its bearing is 182°,, 24m—180° = S. 2°,, 24mW. (To reduce angles in the second quadrant subtract them from 180).

From these data the Latitudes and Departures would be computed, and the bearing and distance of a road to be driven from *f* to *a* calculated as follows:—The Latitude of a line is the Cosine of the angle it makes with the meridian, multiplied by the length of the line, or in other words, the distance due N. or S. between the ends of the line.

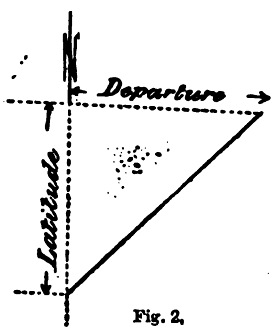


Fig. 2.

The Departure of a line is the Sine of the angle it makes with the meridian, multiplied by its length, that is, distance due E. and W. between the ends of line; thus the Latitude and Departure of a line being known, its end can be found by two measurements.

end of the survey (or any intermediate point if required) can be put on the plan by a couple of measurements with absolute precision.

The calculations may be very much simplified, either by the use of Logarithms, when addition is substituted for multiplication, or by transverse tables, in which the Latitudes and Departures are worked out for any length of lines at any angle.

In Figure I, is the direction and bearing of the road *f a* is all that is required, no plotting will be necessary; the calculations would be made as follows:—

	Bearing	Distance	Latitude North	Latitude South	Departure East	Departure West
a b	N. 84°—6mE.	436	44·81	...	433·69	...
b c	N. 74°—12mE.	318	86·60	...	306·0	...
c d	N. 88°—18mE.	277	8·22	...	276·85	...
d f	S. 2°—24mW.	720	...	719·36	...	30·15
			139·64	716·36	1016·54	30·15

S. 719·36	E. 1016·54
N. 139·64	W. 30·15
579·72 South	986·39 East

The point *f* can be set off by measuring 579·7 due S. and 986·4 due E. from *a* (Fig. I), and it will be seen that *a f* is the hypothenuse of the right angled triangle *a f g*, and its length may be got from the usual rule:—

$\sqrt{579{\cdot}7^2 + 986{\cdot}4^2} = 1144$ = length of *a f*.

To find the bearing of *f a* :—

$$\frac{\text{Latitude}}{\text{Length of hypot}} = \text{Cos. of bearing, or}$$

$$\frac{\text{Departure}}{\text{Length of hypot}} \quad \text{Sine of bearing.}$$

[This will be understood when it is remembered that the Latitude is the Cos., and the Departure is the Sine of a triangle *a f k*, which triangle is about a circle whose radius is *a f*, and in trigonometrical tables the figures given are for a radius of 1.]

The bearing of *a f* will be found thus—

$$\frac{579 \cdot 7}{1144} = \cdot 50673, \text{ which is the Cos of } 59^\circ\text{—}33^{m}$$

$$\text{or } \frac{986 \cdot 4}{1144} = \cdot 86224, \text{ which is the Sine of } 59^\circ\text{—}33^{m}$$

Therefore a road driven from *a* to *f* would bear N. 59°—33^{m} W., and would be 1144 links long; this might be checked by plotting with a protractor, but the calculated results will be the more correct.

In plotting a survey of 50 or more sights in the usual way with a protractor, there is plenty of scope for error, as very minute inaccuracies in each sight might accumulate seriously, and one cannot always rely upon little inaccuracies balancing each other. The advantage of calculations over plotting is very apparent when a complete traverse has been made, in which case, of course, the Latitudes and Departures should all cancel out; the amount of error made in the survey is found absolutely, whereas, when plotting an extensive survey, one can hardly rely upon getting nearer than 10 or 15 links, so an error of say 10 links in plotting might conceal, but not counteract, an error of the same amount in the survey, and the plan would appear to be 20 links more correct than it really was.

This system has many advantages over the "fast needle" method. Each bearing is observed several times, so a mistake is impossible, and any error in the division of the dial or theodolite plate will be regulated, and it is so very simple a matter to measure the angle one road makes with another, that it seems unnecessary to get at it by measuring the angle each line makes with another line —as is done in "fast needle" work— especially as the other line, that is, the magnetic meridian, is unstable and affected by such things as sun spots and loose wedges.

By angular surveying, too, each sight is checked as it is made, whereas in fast needle work, it is, as a rule, impossible to get frequent "loose needle sights"; often a reliable base can only be arranged for at the beginning and end of the survey, and if, at the end of a tedious survey, the needle does come a little out, the surveyor, not being very anxious to do his work over again, is apt to accept a rather lower standard of accuracy than may be desirable. Much excellent work is done by "fast needle surveying, but the magnetic meridian is not likely to long remain the base for plans of extensive workings, though it is most convenient for filling in details, surveying through faces, and such like.

COMPETITION QUESTIONS.

We make an uniform award of 2s. 6d. to the sender of the best answer to each of the questions given. Answers to be as brief as possible, and sketches must be made when necessary. One or all of the questions may be answered.

Envelopes to be marked "COMPETITION," and to reach us before Novembber 1st, 1895.

We invite readers to forward questions for this competition.

(1) State what experiments you would have made, and to what points you would specially direct attention, if required to report on the efficiency or otherwise of the brake on a pair of 24-inch winding engines, winding coal from several depths in one shaft by means of two cages.

(2) Show by sketches (plan and section) how you would timber the working face on the long wall system in a mine 500 yards deep, and where the coal is 4 feet thick, working upbrow at an inclination of 1 in 10. Give the distance you would set the props and sprags apart.

(3) If you had to repair the brickwork in an upcast shaft, what sort of scaffold would you use? Give sketch.

AWARDS

FOR ANSWERS TO COMPETITION QUESTIONS.

Question 1.—James Davies, 151, Manchester Road, Tyldesley.

Question 2.—Ralph Anderson, 23, John Street, Newfield, Pelton Fell, Durham.

Commended.—Thomas Smith, S. Davies, J. Davies, R. Anderson, T. Beresford, T. Martin, J. E. Keefe.

ANSWERS TO CORRESPONDENTS.

JESSE PILGRIM.—Sorry we omitted to mention your name last issue as having sent in correct solution to ventilation query, etc., by "Willie." It was entirely an oversight.

JOHN N. WARDELL.—Your answer to "Ignorant" on Surveying asked in our correspondence column in No. 22 will be inserted in next issue with sketches as sent.

A. E. MILLWARD.—Will review next issue.

ANSWERS TO COMPETITION QUESTIONS

In No. 20, Vol. III.

(*Held over from last issue.*)

SURVEYING.

(1) No suitable answer received.

DISLOCATIONS OF COAL MINES.

(2) State the nature of the dislocations of coal mines, their probable origin, their appearance vertically and on a horizontal plane, and the usual methods adopted for regaining the severed portions. Give horizontal and vertical illustrations of dislocation.

Answer.—These dislocations may be either simple fissures, that is, rents or cracks without any vertical displacement, or faults where the rocks have not only been rent, but where one side has been pushed up or sunk down. When speaking of a fault then, we understand the term to mean an interruption of the continuity of a bed or stratum. These faults may have been produced by one of a multitude of causes, and the area of barren ground between the disturbed and dislocated seam or seams may vary from a mere chink to many yards. Faults are sometimes vertical, but more generally they are more or less inclined. The largest faults (that is, those which have the greatest vertical displacement) slope at very high angles, whilst those of only a few feet or yards have generally very low angles. The horizontal distance to which the dislocated seams are removed from each other does not depend upon the amount of vertical displacement, but rather upon the angle of the hade, or in other words, upon the inclination of the fault. It is obvious then that the angle of a fault must seriously affect the value of a coalfield, because the lower the angle the greater will be the area of barren ground intervening between the faults, and, hence, the more vertical the lines of the fault the better for the value of the coalfield. There are various kinds of faults, viz., the ordinary, the reverse, the vertical, and the trough fault, &c. The usual methods adopted for regaining the severed portions are for an ordinary fault by Schmidt's law—that is—by searching on the side of the greater angle, so that a mere inspection of a fault in this case will suffice to show which is the upthrow side, and in mining operations this rule is nvaluable, because it decides whether a coal seam which has been dislocated is to be sought for by going up or down. The disturbed seams are generally recovered by driving a drift after ascertaining by boring the amount of vertical displacement. When a fault is vertical, the position of the faulted seam can only be ascertained by boring, and a close examination of the strata. On approaching a fault, the inclination of the seam is often considerably altered, and the coal itself frequently presents a smudgy appearance, and often bends or inclines at the edges towards the faulted seam. Sometimes instead of being a check to the flow of water, the opposite has been experienced. As some of the most dangerous discharges of water have taken place at these faults, they also give oft quantities of dangerous gases, such as CH_4, CO_2, CO, and SH_2. They are caused when the strata can no longer bend under the weights that act upon them, such as lateral or side pressure, and thus give way causing a dislocation. These dislocations form some of the most contingent elements the mine manager has often to contend with when working his calculations as to the number and positions of the shafts, and the plant which would be most suitable and beneficial after proving the strata on the different parts of the royalty. They are always difficult to deal with and very expensive to pass through, rendering the question as to the quality, thickness, &c., of the seam beyond very doubtful, and interfere very seriously with the progress altogether. They break up the regular inclination of the seam and the surrounding rocks, and prove to be very injurious both to the drainage, ventilation, and greatly reduce the general output.

Matthew Mowvley.

(Our contributor seems to think that faults are an unmitigated bane. It must be remembered, however, that many of our present coalfields would have been unworkable had they not been upheaved by faults and so brought within workable depth.—Ed.)

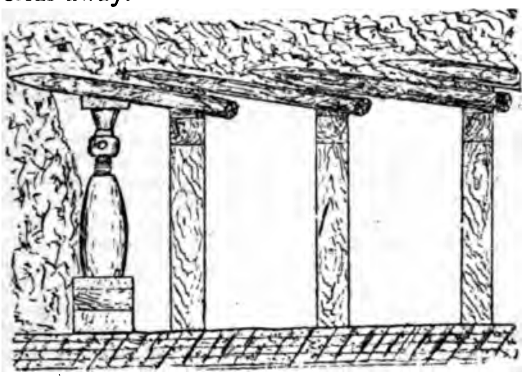
PRELIMINARY NOTICE.

We wish to remind our readers that the present volume will be concluded with the 26th issue on November 16th. Having been requested by several of our readers to supply Cases for binding, we purpose having a few made which will be ready shortly. The cases will be in cloth, gilt, lettered, with title page and index. Price one shilling and sixpence. To be had from "*Mining*" *Office only*. Further particulars next issue.

QUESTIONS given in No. 21, Vol. III.

FALL OF ROOF IN MAIN ROADS OF A MINE.

(1) A large fall occurred on one of the main roads of a mine. A man is buried under it, but is not dead. It is a fiery mine. State your mode of procedure, and from which end of the fall you would commence to clear away.



Answer.—I should proceed to clear away the fall at the nearest end to which the man was imprisoned. To ascertain where the man lay I would give repeated shouts and approximate his position by the sound of his answers. If no answer was received—but it was yet thought probable that the man lived—I would commence operations simultaneously at both ends of the fall. The nature of the debris and overhanging rock should be taken into consideration, and timber set according to the circumstances. If the rock was hard I would set a bar at the end of the fall, and commence removing the fallen debris as carefully as possible so as not to disturb any pieces held in suspension, setting timber as I proceeded to clear the place up. Frequently in in such a case as stated in the question, the rescuers do not trouble to fix timber and often endanger their own lives, as well as make it more difficult to release those imprisoned. If the strata was loose—though this is improbable—the best means of clearing the fall would be to set timbers in the ordinary manner and drive piles over the top into the loose strata (see sketch) so as to prevent any more falling. It is usually necessary to employ a screw-jack when timbering in this method to lift up the ends of the piles to enable the next set of timbers to be fixed. Before commencing to clear away the fall, however, the place should be examined for gas and if any was found arrangements must, be made for clearing away or rendering it harmless. The gas can be removed only by means of a ventilating current, and this I would direct on to the place with brattice or by some other arrangement according to the position of the road. It might also be advisable to stop a portion of the air of another district so that it might be used in assisting to clear away the gas. While the men are engaged in clearing up the fall stretchers and bandages could be had in readiness on the spot in case they were required.

JAS. DAVIES.

WINDING ARRANGEMENTS.

(2) What size of shaft and what winding arrangements generally would you employ to wind 1000 tons of coal per day from a depth of 800 yards? Take capacity of tubs as 10 cwt.

Answer.—Allow one hour for lowering and raising men, waiting for coal, &c., leaving nine hours per day of ten hours for winding 1000 tons. Quantity to be wound per hour $= \frac{1000}{9}$ = say 110 tons. Say speed per second = 30 feet. Then $\frac{800 \times 3}{30} = 80$ seconds per wind. Changing = 10 seconds. Total time for each complete wind = 80 + 10 = 90 seconds. Quantity per wind = 3600 : 90 : : 110. Capacity of tubs = 10 cwts. = 6 tubs $= \frac{90 \times 110}{3600} = 2\frac{3}{4}$ tons, say 3 tons. Weight of tub = 5 cwts. half of capacity of tub. Weight of cage for 6 tubs, each weighing 15 cwt., will be about 3 tons. Total weight per wind = coal + weight of tubs + cage + weight of rope = 3 tons + 1 ton 10 cwts. + 3 tons + weight of rope. Size of rope for working load of 7 tons 10 cwts. is found thus:

$$C^2 \times 3 = \text{S.W.L.} = 7\tfrac{1}{2}\text{ tons} + \frac{C^2 \times \cdot 45 \times 800}{2240}$$

$$\therefore (C^2 \times \cdot 3) - \frac{C^2 \times 2\cdot 25}{14} = C^2 \times \cdot 3 - \frac{C^2 \times 9}{56} = 7\tfrac{1}{2}\text{ tons}$$

$$\therefore \left(\frac{3}{10}\right) - \frac{9}{56} C^2 = 7\tfrac{1}{2}\text{ tons}$$

$$\therefore \frac{84 - 45}{280} C^2 = 7\tfrac{1}{2}\text{ tons}$$

$$\therefore \frac{39}{280} C^2 = 7\tfrac{1}{2}\text{ tons}$$

$$\therefore C^2 = 7\tfrac{1}{2} \div \frac{39}{280} = \frac{700}{13} = 54\text{ ins. nearly}$$

$$\therefore C = \sqrt{54} = 7\cdot 34,\text{ say } 7\tfrac{1}{2}\text{ inches}$$

Weight of $7\frac{1}{2}$ inch rope $= 7\cdot 5 \times 7\cdot 5 \times \cdot 9 \times 400 = 9$ tons.

For a pit of this depth I would have a spiral drum, the small diameter of which must be for a $7\frac{1}{2}$ inch rope $= 7{\cdot}5 \times 3 = 22{\cdot}5$ feet. Large diameter : small diameter :: $F + E + 2R : F + E \therefore F + E : F + E + 2R :: S : L$.

Where $F =$ full cage, $E =$ empty cage, $2R =$ twice weight of rope, $\therefore 7\frac{1}{2} + 4\frac{1}{2}$ tons : $7\frac{1}{2} + 4\frac{1}{2} + (2 \times 9)$ :: $22\frac{1}{2}$ feet : L.

$$\therefore L = \frac{30 \times 22\frac{1}{2}}{12} = 56\tfrac{1}{4} \text{ feet.}$$

There should be a portion of the drum cylindrical at the small diameter to support two or three coils of rope, so that there is not much tension on the rope where it is attached to drum, and the drum is cylindrical at its large diameter for three coils, so as to aid the engine in starting and stopping. Say there are three coils of rope on that part at the start of a wind, viz., the large diameter $56\frac{1}{4}$ feet. Then $56\frac{1}{4} \times 3\frac{1}{7} \times 3 = 530$ feet of rope on the cylindrical part, leaving $2400 \div 530 = 1870$ feet for the spiral part; then the average diameter of spiral part $= \frac{56\frac{1}{4} + 22{\cdot}5}{2} = \frac{78{\cdot}75}{2} = 39{\cdot}375$ feet; then number of revolutions $= 3 + 1870 \div (39{\cdot}375 \times 3\frac{1}{7}) = \frac{1870}{123{\cdot}65} = 18\frac{1}{8}$ per wind.

Useful work in each wind $= 60 \times 112 = 6720$ lbs.; $800 \times 3 = 2400$ feet, height of lift; then $2400 \times 6720 = 16128000$ foot lbs. to be raised. The steam will not be shut off until about the 16th or 17th wind, say 16, then the work of steam (with useful effect of 50 per cent.) in each revolution $= \frac{16128000 \times 100}{16 \times 50} = 2016000$ foot lbs., average pressure of steam in cylinders $= 20$ lbs., in boilers 40lbs. The engine will make 14 revolutions per minute or 28 single strokes.

$$\frac{420}{28} = 16 \div 2 = 8 \text{ feet length of stroke.}$$

$$D^2 \times {\cdot}7854 \times 2 \times 20 \times 8 \times 2 = 2016000 \text{ ft. lbs.}$$

$$\therefore D^2 = \frac{2016000}{{\cdot}7854 \times 2 \times 20 \times 8 \times 2}$$

$$= \frac{2016000}{{\cdot}7854 \times 640} = \frac{2016000}{502{\cdot}656} = 4010.$$

$$\therefore D = \sqrt{4010} = 63 \text{ inches.}$$

Summary of Answer.—A double horizontal engine, 63 inch cylinders, 8 feet stroke. Spiral drum, $22\frac{1}{2}$ and $56\frac{1}{4}$ feet diameters. Cage (treble-decked, each deck holding two tubs) weighing 3 tons, 3 tons of coal in six tubs of 10 cwt. each, and each weighing 5 cwts. Ropes, $7\frac{1}{2}$ inches of best plough steel. Winding and changing in 90 seconds. Steam pressure in boilers 40 lbs. per square inch. In cylinders 20 lbs. RALPH ANDERSON.

[Drum unreasonably large, boiler pressure too low, and, consequently, cylinders too large.—ED.]

EDITORIAL NOTES.

The report of Messrs. C. J. Guthrie and J. M. Ronaldson on the circumstances attending the explosion which occurred in the Quarter Colliery, Denny, Stirlingshire, on April 26th last, and by which 13 men lost their lives, has been recently published. It appears that upon the bodies of eight of the number were found matches, pipes, and tobacco, and contrivances for unlocking lamps—in no less than four instances were matches found. The report states that in their opinion the explosion was caused by the ignition of an outburst of gas coming in contact with a naked light other than an open safety lamp, which had been unlawfully kindled either by the fireman or by one of the miners who were killed. The intensity of the explosion was in their opinion aggravated and its area extended by the ignition of the coal dust.

* * *

The annual meeting of the South Staffordshire and East Worcestershire Institute of Mining Engineers was recently held at Mason College, Birmingham, and Mr. J. H. Cooksey was elected president. A paper was read by Mr. I. Meachem, jun., on an electric power plant, and another contributed by Mr. F. G. Meachem, on the subject of *Lathyrus* poisoning amongst the horses at Hamstead Colliery.

* * *

The annual meeting of the South Staffordshire Mines Drainage Commission was held on Wednesday, the 2nd inst., at Dudley. The principal item under consideration was the drainage of the Tipton district, of which Mr. Howl states that during the year the mineral raised exclusive of the mines altogether exempt amounted to 701,887 tons. Twenty-six tons of water were raised in the district for one of minerals, the cost of raising the water being ·21d. per ton.

* * *

An explosion of gas occurred at the Wellington Colliery, Tyldesley, near Manchester, on Tuesday, the 1st inst, when five men, including the under-manager, lost their lives. It appears the men were endeavouring to remove a dangerous accumulation of gas when the accident occured. At the inquest, Mr. J. Gerard, H.M.I.M., remarked—He should say that safety lamps were intended entirely as a protection and to discover gas if need be. If it was discovered they must take steps to remove it without going into it. It was a distinct abuse of the safety lamp to use it in gas. He spoke most decisively on that point. If any latitude were given, it was very liable to be abused, and he said absolutely there should be no working in gas, not even with a safety lamp. This accident was distinctly the result of a reckless abuse of the safety lamp.

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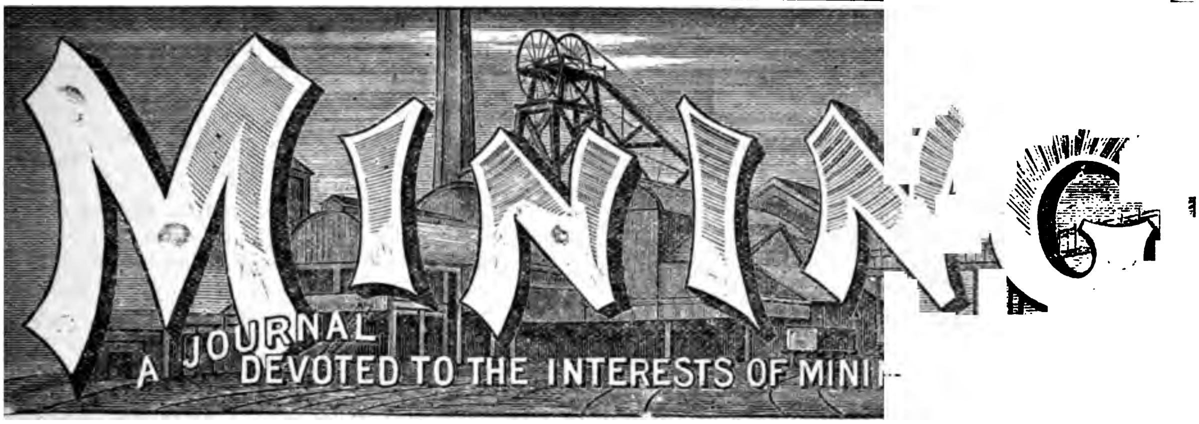

o. 25. Vol. III. SATURDAY, NOVEMBER 2, 1895. **FORTNIGHTLY.** ONE PENNY.

CONTENTS.

EASY LESSONS ON

MINE VENTILATION.

By J. CARTER, First-Class Certificated Manager.

(Commenced in No. 9, Vol. III.)

EXAMPLE I.—Say we have two roads, one 9 feet by 6 feet and the other 13 feet by 7 feet, what is the proportion of friction in the two roads, (A) for same quantity, (B) for three times the quantity of air?

$$R = \sqrt{\left(\frac{A^3}{S}\right)}$$

We may omit the sign of the square root, and the result will not be altered, because R must be the same in each case.

The relative resistances in the two roads for the same quantity of air are as—

$$\frac{54^3}{30} : \frac{91^3}{40} :: 1 = \frac{157464}{30} : \frac{753571}{40} :: 1 = 3{\cdot}54$$

In this case the resistance offered by the airway, 9 feet by 6 feet, will be 3·54 times greater than the other road. When three times the quantity of air is circulated through the airway, 13 feet by 7 feet, the comparison of friction is made thus:—

$u = K\ S\left(\frac{q}{a}\right)^3$ or $K\ S\ V^3$ = relative resistances, K being a common factor and its value the same in each case may be omitted, and R (relative resistance) $= S\ V^3$. Take the velocity in the airway, 9 feet by 6 feet, as 162, then the velocity in the other will be $(162 \times 3) = 486$. Relative velocities must then be as follows:—

$$\frac{162}{54} = 3 \text{ and } \frac{486}{91} = 5{\cdot}34$$

Relative pressures will be (taking the perimeter for rubbing surface):—

Airway No. 1 $= 30 \times 3^3 = 810$
Airway No. 2 $= 40 \times 5{\cdot}34^3 = 6090{\cdot}93$

$\therefore\ \frac{6090{\cdot}93}{810} = 7{\cdot}579$ times greater amount of friction in No. 2 Airway than in No. 1 Airway when passing through three times the quantity of air.

EXAMPLE II.—If we wanted the same quantity of air to pass in two different airways, whose sizes were 7 feet square and 9 feet by 5 feet. In the first airway the water-gauge reads ·5, what will it read in the second road?

$$\text{Formulæ—}\quad P = \frac{K\ S\ V^2}{A}$$

K being a common factor in both cases may be omitted. Here we may also take the perimeter as rubbing surface. The relative velocities will be in proportion to the area of the roads, thus:—

45 : 49 or as 6·42 : 7

To find the proportionate value of pressure in both airways proceed thus—

$$\frac{28 \times 6{\cdot}42^2}{49} : \frac{28 \times 7^2}{45} = 23{\cdot}53 : 30{\cdot}48$$

Pressure in smaller airway is $\left(\frac{30{\cdot}48}{23{\cdot}53}\right) = 1{\cdot}29$

times greater in the larger one. The water-gauge in the airway, 7 feet by 7 feet, being ·5, then the water-gauge in the smaller road is $({\cdot}5 \times 1{\cdot}29) = {\cdot}645$ inches.

EXAMPLE III.—We have an airway, 6000 feet long, 5·5 feet high, and 8 feet wide, passing 15000 cubic feet of air per minute, suppose we want to pass 45000 cubic feet of air per minute with the same pressure. How much should we have to enlarge the area in the same rectangular form so as to offer the same resistances?

The ratio of increased quantity would be—

$$\frac{45000}{15000} = 3, \text{ and } (3)^{\frac{2}{5}} = 1{\cdot}55184$$

so that the height of the altered airway must be $1{\cdot}55184 \times 5{\cdot}5 = 8{\cdot}53512$ feet, and the width $1{\cdot}55184 \times 8 = 12{\cdot}41472$, so that in this case the dimensions of the altered airway must be 8·53512 feet high and 12·41472 feet wide.

To prove this without the use of logarithms the extraction of the 5th root is very tedious, especially if the answer required contains several figures, however, the method employed is as follows, the answer of which I have only worked out to two places of decimals, which can be carried further if desired by a continuation of the method below:—

$$(3)^{\frac{2}{5}} = \sqrt[5]{3^2} = \sqrt[5]{9} = 9{\cdot}00000\,(1{\cdot}55$$

		1
$5 \times 10^4 =$	50000	800000
$10 \times 10^3 \times 5 =$	50000	
$10 \times 10^2 \times 5^2 =$	25000	
$5 \times 10 \times 5^3 =$	6250	
$5^4 =$	625	659375
	131875	14062500000
$5 \times 150^4 =$	2531250000	
$10 \times 150^3 \times 5 =$	168750000	
$10 \times 150^2 \times 5^2 =$	5625000	
$5 \times 150 \times 5^3 =$	93750	
$5^4 =$	625	13528596875
	2705719375	533903125

To prove that the size of our airway as calculated is correct we have only to apply Atkinson's formulæ and find the pressure in both cases, thus—

Airway before enlargement:—

$$P = \frac{{\cdot}0217 \times 251398 \times 11621}{44} = 9{\cdot}28 \text{ lbs.}$$

Airway after enlargement:—

$$P = \frac{{\cdot}0217 \times 251398 \times 18033}{105{\cdot}96} = 9{\cdot}28 \text{ lbs.}$$

EXAMPLE IV.—If 20000 cubic feet of air per minute pass through an airway, 8 feet square, how much will pass through the road if it were reduced to 4·5 feet by 3·5 feet, power remaining the same?

$$\text{Formulæ—} \quad q = \sqrt[3]{\frac{u}{KS}} \times A$$

We have no length of airway given, therefore we may substitute the perimeter for rubbing surface, also the relative values will not be affected if K, which is common to both airways, be omitted.

$$\therefore \; q = \sqrt[3]{\frac{u}{P}} \times A$$

We have here no actual value given to us, therefore, for simplicity and convenience, we will call it 32, being a multiple of the perimeter, and the proportion will be as follows:—

$$\sqrt[3]{\frac{32}{32}} \times 64 : \sqrt[3]{\frac{32}{16}} \times 15{\cdot}75 :: 10000$$

$$= 64 : \sqrt[3]{2} \times 15{\cdot}75 :: 10000 : 3100{\cdot}58$$

cubic feet per min. for the smaller aircourse.

EXAMPLE V.—In an airway, 12 feet by 6 feet, passing 20016 cubic feet of air per min., with a pressure of 12 lbs. per square foot, what is the length of the airway?

Formulæ—

$$S = \frac{PA}{KV^2} = \frac{12 \times 72}{{\cdot}0217 \times \left(\frac{278}{1000}\right)^2} = 515126$$

square feet of rubbing surface. The perimeter of the airway is 36, therefore the length of the airway is—

$$\frac{515126}{36} = 14307 \text{ feet long.}$$

EXAMPLE VI.—If an airway be doubled in length, whilst the area of section and pressure remained the same, what will be the effect on the velocity, supposing, in the first case, we had a velocity of 200 feet per minute?

$$\sqrt{\tfrac{1}{2}} \times 200 = 151{\cdot}42$$

showing a diminution of 48·58 feet per min.

EXAMPLE VII.—What is the difference in pressure per square foot in the two shafts of a mine (downcast and upcast) under the following circumstances: Average temperature of air in downcast, 47 degrees; upcast, 200

degrees; barometric pressure, half-way down the shaft, say 30·75 inches; depth of shaft is 800 feet?

Downcast $W = \frac{1·3253 \times 30·75}{459 + 44} = ·08082$ lbs. per cubic foot and $·08082 \times 800 = 64·656$ lbs. total pressure per square foot.

Upcast $W = \frac{1·3253 \times 30·75}{459 + 200} = ·06058$ lbs. per cubic foot. and $·06058 \times 800 = 48·464$ lbs. total pressure per square foot.

$\therefore \; 64·656 - 48·464 = 16·192$ lbs. per square foot difference in pressure between the two shafts.

(*To be continued.*)

THE ENGINEERING OF COLLIERIES

Being a Treatise on Colliery Machinery, Appliances, and Constructions.

By T. A. O'DONAHUE.

(Commenced in No. 9, Vol. III.)

BANKING ARRANGEMENTS.—Continued.

WHETHER a shaft should be fitted with single, double, or trebled-decked cages, and whether the banking should be effected on one or more landings depends entirely upon the circumstances. For example, we are well aware that with a double-decked cage banking on one landing, the time occupied in banking will be twice that which would be required if the two decks were changed simultaneously on two landings, but it would be irrational to jump to the conclusion that because time is saved, banking the decks simultaneously must be the better course to adopt in every case. If the mine being worked is of exceptionally good quality, and it is required to obtain as large an output as possible, the better policy would be to have two landings for banking, but if the output is restricted either from commercial or underground considerations, to such an amount as could be satisfactorily banked if only one landing was used, then it would be better from an economical standpoint to have only one landing and to effect the banking from the two decks separately. Assuming that an output of from 600 to 800 tons was required from a shaft, say 500 yards deep, their would be no difficulty whatever in banking this on one landing, and it could be done much cheaper than from two, as only one staff of men would be requisite.

To facilitate the banking the cages should be made so that the tubs on each deck fit end to end, thus allowing the full tubs to be taken out at one end of the cage whilst empty tubs are being put in at the other.

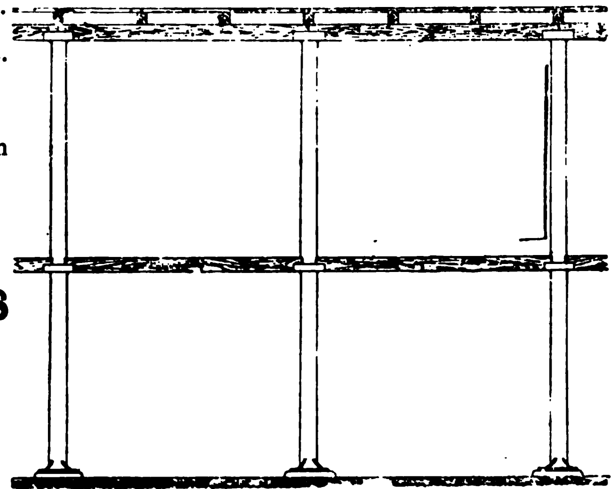

Fig. 45.

THE HEAPSTEAD.

The landing stage or heapstead is now generally constructed of timber supported on iron columns, but in many cases the landing is affected on *terra firma*, sufficient height being gained for screening, &c., by packing up the material brought from the shaft during sinking, the whole being then surrounded by retaining walls. The height of the heapstead depends upon the picking and screening arrangements to be adopted, and may be said to vary between 18 and 25 feet above the rail level. When cast-iron columns are used for supporting the heapstead and also the shed for the belts and screens, they are placed from 10 to 15 feet apart, and pockets or flanges are cast at the top for the reception of the cross-timbers. Those columns which have to support the picking belts, &c., have pockets cast on them about 9 feet 6 inches from the bottom. See fig. 45.

The modern heapstead plant consisting as it does of picking belts as well as screens, necessitates a greater height of heapstead than was formerly required, and this want of height has been a great detriment to those collieries which have found it expedient to add picking belts to their heapstead plant. Rather than raise the whole of the staging to

accommodate the new plant—and this in many instances would also necessitate increasing the height of the headgear—many have preferred to raise only the portion of the staging above the screens to the required height, but the greater portion and the most difficult to alter, viz., about the shaft, has remained untouched. By this arrangement the tippler to which all the wagons must be taken is situated a few feet higher than the cage landing, and some mechanical means must be adopted to raise the full tubs up to this level, as it would be out of the question to have the banksmen pushing them up an incline. Having the tippler fixed a few feet higher than the cage landing is not altogether a disadvantage as will be seen later, for sufficient height is gained to allow the tubs to run back to the shaft again of their own accord, the arrangements being thus made more automatic. The best method of conveying the tubs to the higher level is by means of a creeper chain, though in some cases an elevating table, worked by a steam cylinder and a piston fixed directly under it, is employed.

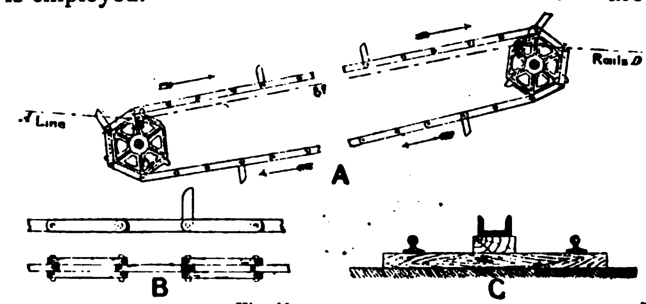

Fig. 46.

The Creeper Chain.

The creeper or finger chain forms an endless band as is shown by fig. 46, the upper half of the chain working in the roadway under the tubs, and the lower half altogether under the roadway. At each extremity the chain passes round a hexagonal wheel or "tumbler"—the length of a side of the hexagon being adapted to the links of the chain. On each alternate side of the tumbler is a cog which fits into the links of the chain and thus gives motion to it. The upper tumbler is of course on the driving shaft, the lower one simply acting as a return wheel. The driving shaft may be worked by gearing or belting, or directly by a small engine, the most general arrangement being to work the chain by the same engine that works the screens and belts. At distances of about 6 feet or more there are vertical fingers or projecting pieces in the chain, these are rigidly fixed and are sufficiently long to engage on the axles of the tubs, and thus convey the tubs up the inclined road on which the chain is working. The chain is formed of pieces of wrought-iron, each of which is from 10 to 16 inches long and with a bolt hole at each end. The thickness and width of the metal is made suitable to the work which the chain has to perform. The chain is constructed by alternately fixing one and two bars in the manner shown by detail sketch B, and fastening them together by bolts or pins. Where a finger or catch is required in the chain, instead of a single bar being fitted in the chain a L piece is employed, the shorter arm acting as a finger, and the longer piece going to complete the chain. It is found necessary to fix a guide in the roadway for the upper half of the chain to travel, in a convenient form of which is shown by sketch C. It consists of lengths of channel iron fastened by countersunk bolts to longitudinal pieces of timber. If the couplings of the tubs hang loosely and are liable to catch on the fingers of the chain, it should be fixed a little to one side of the road so as not to interfere with them. The manner in which the chain does its work is now apparent, the full tub travels down the slight incline A B, and is caught at the tumbler by the next finger in the chain, and is conveyed to the top of the incline at C. The road now dips from E to DC, and the tub therefore runs ahead of the finger and passes on towards D.

The creeper chains are not only employed for the purpose of elevating the tubs, where alterations have been made in the heapstead, but are frequently employed for the original structure, as by their use the banking can be more economically, regularly and quickly performed.

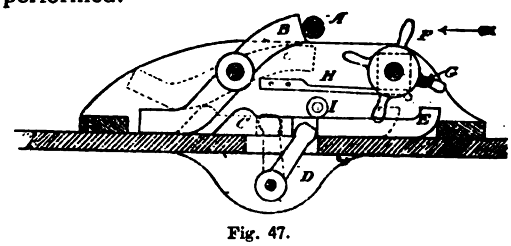

Fig. 47.

Tub Controllers.

The use of the tub controller is to scotch or release the tubs as required on the inclined road on which it is fixed. Woodworth's tub

controller is shown by fig. 47; the appliance is placed in the wagon road and automatically stops the tubs coming down until they are released by a lever, which may be worked at any distance by the banksman. The special advantage of this controller is that it can be made to release a definite number of tubs for each movement of the lever. A tub coming down the incline in the direction of the arrow will catch an arm of the wheel (F), causing it to turn a portion of a revolution; but the first axle (A) of the tub will be stopped by the axle catch lever (B). When the attendant desires to release the tubs a lever turns D into the position shown by the dotted lines. The upper end of D works in a slot in the sliding bar (C E), which is in consequence moved with it, and the end (C) knocks against the lower portion of the axle catch lever, and causes it assume the position shown by the dotted lines, and thus allows the tubs to pass on freely. As the tubs pass the star wheel (F), the axles catch the arms and turn the wheel, so that when three more axles besides A have passed the cam (G) the star wheel will be at its lowest point, and will be a little in front of the heel (E) of the sliding bar, the bar being in the position shown dotted. The next axle that passes over the wheel, therefore, will cause the cam (G) to force the sliding bar back into its original position, thus allowing the lever (B) to fall and again stop the delivery of the tubs. To regulate the motion of the star wheel a spring (H) presses on square projections of the wheel, and the sliding bar (C E) is maintained in its correct path by the roller (I). As four axles must pass the star wheel in the case illustrated for a complete operation, it follows that two tubs are released each time. When it is necessary to release three tubs each time the star wheel is provided with six arms, and if one tub only is required with two arms.

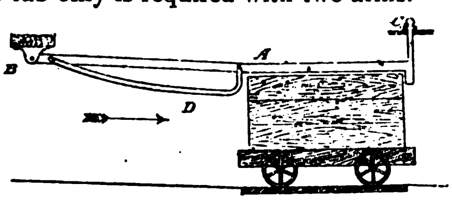

Fig. 48.

Another tub controller, though one used for an entirely different purpose than the foregoing, is shown by fig. 48. It is employed for automatically stopping each tub on an inclined road—where the tubs run singly—until the next tub reaches it when the first tub is released, and the second one retained to be in turn released by the next succeeding tub. This appliance may with advantage be employed to stop the tubs for weighing purposes. It is situated above the tops of the tubs, and consists of a bar (A) which is pivoted at one end (B), and is free to move in a vertical direction at the other, but is prevented from falling below a certain point by a vertical piece which passes through a hole in a fixed supporting bar, and which terminates in a head (C) which rests on the bar. A tub coming in the direction shown by the arrow, strikes the bent bar (D) and turns up the bar (A) on its pivot; immediately the tub passes the bent bar (D), however, the whole drops down and locks the tub as shown, until the next one coming down the incline in the same manner again raises the bar and releases the first tub, but is caught in turn to be held until the next succeeding tub raises the bar to release it. If the tubs travel a few feet apart, as would be the case if delivered by a creeper chain, each tub remains sufficiently long at the weigh table to have its weight recorded, and then pass on automatically.

(To be continued.)

COMPETITION QUESTIONS.

We make an uniform award of 2s. 6d. to the sender of the best answer to each of the questions given. Answers to be as brief as possible, and sketches must be made when necessary. One or all of the questions may be answered.

Envelopes to be marked "COMPETITION," and to reach us before November 15th, 1895.

We invite readers to forward questions for this competition.

(1) Given a pair of hauling engines underground worked by air, compressed 500 yards away; what difficulties may you expect, and how would you guard against them?

(2) In consequence of the stoppage of an adjoining colliery, you have to deal with an additional flow of water which passes through a considerable length of the goaf of a mine in which a large quantity of iron pyrites exists, what precautions would you take in preparing for and dealing with such water?

(3) In sinking a shaft, which has to pass through several seams of coal, state how you would ventilate it, and what precautions you would take?

All communications appertaining to the sale of the paper, agents, etc., to be made to the Publishers, Messrs. E. Marlborough & Co., 51, Old Bailey, London.

RAILWAY RATES ON COAL.

(Specially written for this Journal.)

AMONG the many subjects of importance which are at the present time engaging the attention of the commercial world, few, if any, are of greater interest and importance than the great controversy which is going on, between the railway companies and the traders, with regard to the rates and charges for the carriage of merchandise. A short history of the subject from a general standpoint, and a few remarks as to the effect of recent legislation on the coal trade, will, therefore, not be without interest to the readers of *Mining*. As showing the great importance of the subject it may here be sufficient to call to mind that Select Committees of Parliament, to enquire into and report on the question, sat in the years 1844, 1846, and 1853. A Royal Commission in 1867, a Joint Committee in 1872, and yet a further Select Committee in 1881-2. Various Acts of Parliament have been passed as the result of the inquiries thus held, but for the present purpose it is sufficient to say that, in 1888, the Railway and Canal Traffic Act was passed, which provided, amongst other things, that every railway company should submit to the Board of Trade a revised classification of merchandise traffic, and a revised schedule of maximum rates and charges applicable thereto, and fully state in such classification and schedule the nature and amounts of all terminal charges proposed to be authorised, in respect of each class of traffic, and the circumstances under which such terminal charges were proposed to be made. Prior to the passing of this Act, a trader, in order to ascertain what a railway company's powers were, as to rates and charges, on any particular class of merchandise in which he might be interested, was under the necessity of consulting the various Acts of the different companies, relating to the railway or railways over which the merchandise had to pass, and had, in addition, also to refer to the Railway Clearing House Classification. In many cases it was almost a matter of impossibility to ascertain, *with any* degree of certainty, what the powers of a railway company were, and, consequently, there was much dissatisfaction amongst traders generally. They, therefore, hailed with pleasure the passing of the Act of 1888, for which they had waited and agitated *so long*, and which was intended, as they believed, to be an Act for the relief of traders The Act provided that, when the railway companies had submitted their revised classifications and schedules, the Board of Trade should consider the same, in the case of each company, and that they should also hear any objections thereto by the traders. Accordingly, in 1889, the revised classifications and schedules having been submitted by the various companies, and objections thereto having been lodged with the Board of Trade by the traders, an Inquiry was opened, at Westminster, before Lord Balfour, of Burleigh, and Mr. (now Sir) Courtenay Boyle, on the 15th October, in that year, to consider the various schedules and the objections of the traders of the country thereto.

The Inquiry, at which both the railway companies and the traders were represented by Counsel (though some traders appeared in person), lasted till August, 1890. In the result the Board of Trade found themselves unable to agree with the railway companies' proposals, and it, therefore, rested with them, as provided by the Act, to prepare and submit to Parliament the classifications and schedules *which they thought ought to be adopted by the various railway companies.*

In the first instance the Board of Trade prepared Schedules for the nine principal railway companies having termini in London, and these, in due course, were submitted to Parliament, in the shape of Provisional Order Bills, in the Session of 1891. These Bills, together with the very numerous petitions which had been lodged against them by the various traders throughout the country, were referred to a Joint Select Committee of Lords and Commons, presided over by the Duke of Richmond and Gordon, and, after a prolonged inquiry, were passed into law. They were to have come into force on the 1st of August, 1892, but the date was subsequently altered to the 1st January, 1893.

In the Session of 1892 the Provisional Order Bills relating to the remaining railway companies—including those of Scotland and Ireland—were introduced into Parliament, and, after passing the Joint Select Committee, were duly passed into law, and came into force on the 1st January, 1893.

Under these Rates and Charges Acts, as they now stand, a trader is enabled to ascertain very readily, and with something more approaching certainty, what the maximum powers of any company are, in respect

to the conveyance rates on his traffic, to any point, and also what additional charges they are entitled to make under the head of terminals.

The Acts are called the *Rates and Charges Order Confirmation Acts, 1891 & 1892*, and the scheme of the Act in each case is as follows: (1) The formal Act, which provides that the amended schedule, and the order contained therein, are confirmed, and that all the provisions of the Order, in manner and form as they are set out in the schedule, are, from and after the passing of the Act, to have full validity and effect; (2) the Order of the Board of Trade, which provides that from and after its commencement (*i.e.*, 1st January, 1893), the maximum rates and charges which the particular company to which the Act relates, and the railway companies connected therewith, mentioned in the Appendix,—shall be entitled to charge and make, in respect of merchandise traffic, on the railways of the companies included,—shall be the rates and charges specified in the schedule, and shall be subject to the classification, regulations and provisions set forth in the schedule itself; (3) the "*general conditions*" which regulate the charges which the railway company may make under the head of *station* or *service* terminals, and define the meaning of the several terms used in the Act and schedule; (4) the *special conditions* (if any); (5) the tables of maximum rates and charges; and (6) the classification of traffic. The confirming Act, the Provisional Order, and the classification of traffic, are in all cases similar, but for the change in the name of the Company. The "*General Conditions*" applicable to all the English Companies (except the North Eastern)—are also similar, for all practical purposes. In some cases the Acts relate to *more than one Company*, and this has been effected (1) by including such other Company or Companies in the heading of the Order;—or, (2) by including the other Company or Companies in the appendix.

The schedule, which contains the tables of maximum rates and charges, is divided into six parts:—(1) Merchandise, (2) Animals, (3) Carriages, (4) Exceptional Charges, (5) Perishables, and (6) Small Parcels. Parts 2 to 6, inclusive, are practically the same for all the English Companies, but part 1,—which is the Table of Rates and Terminals in respect of merchandise comprised in the various classes of the classification, is in the following form:—

MAXIMUM RATES AND CHARGES.

PART 1.—GOODS AND MINERALS.

In respect of Merchandise comprised in the under-mentioned Classes.	MAXIMUM RATES FOR CONVEYANCE.			MAXIMUM TERMINALS.					
	For consignments except as otherwise provided in the Schedule			Station Terminal at each End.	Service Terminals.				
	For the first 10 miles or any part of such distance.	For the next 30 miles or any part of such distance.	For the remainder of the Distance		Loading.	Un-loading.	Covering.	Un-covering.	
	Per Ton per Mile.	Per Ton per Mile.	Per Ton per Mile.	Per Ton	Per Ton.	Per Ton.	Per Ton	Per Ton.	

The conveyance rates which—as they affect the coal trade—will be dealt with afterwards, are, it will be observed,—cumulative, and in order to ascertain—for instance—what the rate would be on any particular consignment for 30 miles, on any railway, it would be necessary to take the first 20 miles at the rate given,—per ton per mile,—and then to calculate the next 10 miles at the rate authorised in respect of the next 30 miles.

The merchandise is divided, it will be observed, into Classes A, B. C, 1, 2, 3, 4 and 5.

(To be continued.)

Communications in respect to subscriptions and other business matters to be made to Strowger & Son, Clarence Works, Wigan.

THE LAW RELATING TO

MINES, MINERALS, & WORKERS.

By T. F. UTTLEY, F.I.I., Manchester,
Author of "Factory and Workshop Inspection," Editor of "Labour Contracts," 4th Edition, &c., &c.

(Specially written for this Journal.)

IV.—Rating of Mines, Machinery and Plant.

FORMERLY no mine but a coal mine was ratable, but now all mines, including machinery, engines, buildings, or any other erections are ratable. Quarries of minerals too are ratable. The rates include those to the relief of the poor, and likewise county rates, borough rates, highway rates, and the local rates which are usually imposed upon property which is ratable to the relief of the poor. Surface lands, roads and watercourses are ratable, and shafts, buildings and machinery when used for the purposes of the mine or quarry, and when a person occupies a mine or quarry, having actually and exclusively both the possession of the land and the easement, the building and machinery, and the roads, right of way, wayleaves, wagon ways and watercourses are all liable to the rates, even though the working is under a licence, but a licensee as such is not ratable. The fact that mines or quarries are not profitable does not exempt them from rates if they are being actually worked, but on the other hand rates are not payable until the mine or quarry gets productive, nor when the production ceases, and though the surface lands in such case may be ratable, this will not include buildings, boilers, engines, plant, or railways which have no independent value. The ratability of a mine, therefore, depends on its working, not on its profitableness.

The way in which the ratability of mines or quarries is ascertained is by means of an estimate of the rent at which the same may reasonably be expected to let from year to year, free of all usual tenant's rates and taxes, and tithe commutation rent charge (if any), and deducting therefrom the probable average annual cost of the repairs, insurance, and other expenses (if any), necessary to maintain them in a state to command such rent. This rule did not apply to tin mines and lead mines, and in these cases the ratable annual value of the mines is to be taken to be the annual rent at which the mine might be supposed reasonably to let without a fine or lease of the ordinary duration. Where a tin or lead or copper mine is occupied under a lease or leases granted without a fine on a reservation either wholly or partly of dues or rent, the gross annual value of the mine is to be taken to be the annual amount of the whole of the dues payable in respect thereof during the year ending on the 31st day of December, preceding the date at which the valuation is made in addition to the annual amount of any fixed rent reserved for the same which may not be paid or satisfied by such dues. The ratable annual value of such mine is to be the same as the gross value thereof, except where the person receiving the dues or rent is liable for repairs, insurance or other expenses necessary to maintain the mine in a state to command the annual amount of dues or rent, the average annual cost of the repairs, insurance and other expenses for which he is liable are to be deducted from the gross value for the purpose of calculating the ratable value. Where any such mine is occupied under a lease granted wholly or partly on a fine, or where any such mine is occupied and worked by the owner, or in the case of any other such mine, to which the other provisions as to tin, lead and copper mines do not apply, and of which the royalty or dues are not wholly received in kind, the gross and ratable annual value are the annual amount of the dues or dues and rent at which the mine might reasonably be expected to let without fine on a lease of the ordinary duration, according to the usage of the country, if the tenant undertook to pay all tenants' rates and taxes, and tithe rent charge, and also the repairs, insurance and other expenses necessary to maintain the mine in a state to command such annual amount of dues or dues and rent.

The persons liable for the rates are the actual occupier if in possession by himself, his agents, or servants. The purser, secretary, and chief managing agent for the time being of any lead, tin, or copper mine may, if the overseers think fit, be rated as the occupier. The word "mine"—when a mine is occupied under a lease—includes the underground workings, and the engines, machinery, workshops, tramways, and other plant, buildings (not being dwelling-houses) and works and surface of land occupied in connection with the land, and situate within the boundaries of the land comprised in the lease or leases under which the dues and rent are payable or reserved. By "dues" are meant dues, royalty, or toll, either in money or partly in

that and partly in kind; and the amount of dues which are reserved in kind means the value of such dues. The term "lease" means lease or sett, or licence to work, or an agreement to that effect, and the term "fine" is considered to mean fine, premium, or foregift, or other payment or consideration in the nature thereof.

Where any poor or other local rate, which at the commencement of April, 1875, any lessee, licensee, or grantee of a mine was exempt from being rated to, in respect of such mine, became payable by him in respect of such mine during the continuance of his lease, grant or licence, or before the arrival of the period at which the amount of the rent, royalty, or dues, was liable to revision or readjustment, he might (unless he had specifically contracted to pay such rate in the event of the abolition of the said exemption) deduct from any rent, royalty, or dues, one half of any such rate paid by him, provided that he should not deduct any sum exceeding what one half of the rate in the pound of such poor or other local rate would amount to, if calculated upon the rent, royalty or dues. Any payment so authorised to be deducted is a good discharge for such amount of rent, royalty or dues, as is equal to the amount of such payment, and it may be recovered as an ordinary debt from the person to whom the rent, royalty or debt may be payable, and the person so receiving the rent, royalty or dues has the same right of appeal and objection, as he would have if he were the occupier.

The gist of the law with regard to rating is that all mines and quarries are liable to be rated; the occupancy of a mine makes the property ratable; the mine must be rated as soon as it is at work, continue rated only during the time that it is productive; the proof of value need not indispensably rest upon the actual amount of rent paid to the landlord, but must be assessed as is now the custom; all underground workings, and the machinery and plant, and lands occupied therewith, whether descending to the heir or executor, or belonging at the end of the lease to the landlord or tenant, have to be included in the valuation.

As church rates come under the description of land, mines and quarries would appear to be liable to them.

Tithes are not usually payable in respect of mines, but they may be payable by special custom as in the case of some parts of Derbyshire. They do not come within the Tithe Commutation Acts, but may be made the subject of a parochial agreement under the Tithe Commutation Act.

Income tax is payable on all profits arising from mines and quarries situate in the United Kingdom, and on the profits of mines and quarries accruing to persons resident in the United Kingdom, from mines and quarries situate out of the United Kingdom, whether reserved in the form of royalties or rents.

ANSWERS TO COMPETITION QUESTIONS

In No. 22, Vol. III.

PUMPING ARRANGEMENTS.

(1) What size of pumps and engine would you erect to pump 600 gallons of water per minute from a depth of 100 fathoms. Give a general description of the engine you prefer with the principal sizes.

Answer.—I would adopt in this case a double-acting steam pump, fixed at the bottom of the shaft, and force the water to the surface. This type is more convenient, more portable, and easier worked than those fixed on the surface. The liability to drowning can be avoided to a certain extent by fixing the pump in a special chamber and only allowing as much water to pass into it as the pump can raise. This is done by using a self-acting tap and ball arrangement. They can be applied to lifts of a thousand feet, as the water is always flowing in the same direction, the movement during the reversal of the stroke being kept up by an air reservoir. The cost is low, breakages are rare, and the space occupied by them in the shaft is small. I would employ the plunger type of pump, this being preferable for high lifts. The first point to consider in calculating the size of pump is the piston speed, a good and safe velocity being 100 feet per minute. If 600 gallons have to be delivered every minute this will be 6 gallons delivered for each foot the pump works. One gallon of water contains 277·25 cubic inches, this multiplied by 6 gallons = 1663·5 cubic inches delivered for each foot the pump works.

$$\therefore \frac{1663{\cdot}5}{12} = 138{\cdot}6$$

is the area in square inches of the required water column. If the piston rod of the pump is put at 4 inches diameter its area will be 12·566 inches, and this added to the area of water column makes the area of the required plunger to be—

$$138{\cdot}6 + 12{\cdot}566 = 151{\cdot}16 \text{ sq. in.}$$

∴ diameter of required plunger—

$$= \sqrt{\frac{151{\cdot}16}{{\cdot}7854}} = 13{\cdot}8 \text{ in.}$$

The height to which the water has to be lifted is 600 feet, the pressure per square inch will therefore be—

$600 \times {\cdot}433$ (pressure per sq. inch due to each foot of depth) $= 259{\cdot}8$ lbs.

∴ total pres. $= 138{\cdot}6 \times 259{\cdot}8 = 36026{\cdot}28$ lbs.

We will assume the steam pressure at 60 lbs. per square inch. The area of the steam cylinder, therefore, should be—

$$\frac{36026{\cdot}28}{60} = 600{\cdot}4 \text{ sq. in.}$$

One-half of this area should be added for frictional resistance, etc., making the area 900·6 square inch ∴ diameter of steam cylinder—

$$= \sqrt{\frac{900{\cdot}6}{{\cdot}7854}} = 34 \text{ in. dia.}$$

The pump ought to have 14in. rams, and the steam cylinders to be above the work required should be 36 inches diameter.

From rules given by "Perry" the principal sizes of the engine having a cylinder 36 inches diameter are as follows:—

Length of stroke $= 36 \times 2 = 72$ inches.
Dia. of piston rod $= 36 \div 6 = 6$ inches.
Thickness of cylinder $= \frac{36+5}{20} = 2$ inches.
Length of connecting rod $= 72 \times 2$ as a minimum $= 144$ inches.
Dia. of crank pin $= 36 \times {\cdot}25 = 9$ inches.
Dia. of fly-wheel $= 72 \times 3 = 216$ inches.

To enable direct-acting steam pumps to work smoothly and regularly, and perhaps with more economy, fly-wheels should be added. THOS. WATSON.

PUMPING BY ELECTRICITY.

(2) Give a brief description of the generating, conducting, and applying a current of electricity to work a pump underground.

Answer.—The dynamo is a machine which converts mechanical energy into electrical energy, or, in other words, the dynamo is a generator, which consists of an armature, or a number of coils of insulated wire wound round an iron core, having a commutator of strips or bars of copper placed side by side, but insulated from each other, to form a cylinder, the ends of the insulated coils of the armature being connected to them. Here we have two collectors, called brushes, fixed on rockers for easy adjustment, and consisting of thin strips of copper wire or gauze, which press lightly on the commutator. Connected with this we have the magnet, which is a piece of soft iron bent in the form of a horse-shoe with insulated wire coiled round it for the circulation of the electric current. The magnet is attached by an armature shaft and pulley and is constructed on a suitable frame.

The Action of Generating Power.—When the armature is revolved by means of a steam engine between the poles of the magnet the slightest amount of residual magnetism present in all soft iron induces a current of electricity in the coils of the armature, and if the current collected at the brushes is allowed to pass through the coils which encircle the arms of the magnet it will increase the strength of the magnet until it reaches its full intensity, or the magnet may be excited separately. The full current collected by the brushes passes direct into the cable for available use, except where a portion of it is necessary for exciting the magnet. The dynamo is capable of converting about 96 per cent. of the mechanical energy expended in revolving its armature into electrical energy. The above is termed a continuous current dynamo, but they may be also constructed to give "alternating currents," that is, the current changing several thousand times per minute, they, however, give practically a continuous and steady flow. We must remember that there are different kinds of dynamos used in transmitting power, viz., series-wound, shunt-wound, compound-wound and separately-excited, which is magnetised by a separate small dynamo. The most preferable are those with long bearings, heavy shafts, and strongly built.

The Electric Motor.—The electric motor may be considered as a dynamo in which electrical energy is transformed into mechanical energy. The dynamo is sometimes called the "generating-dynamo," and the motor the "motor-dynamo," to distinguish them.

The Transmission and Application of Electrical Energy.—The dynamo may be driven direct by a high-speed steam engine, or by some other power, usually connected to the dynamo by band or belting, to generate a current of electricity. The current is then transmitted by means of cables or conductors, consisting of stranded wires attached to another dynamo (motor), and the electrical energy is thus transformed into mechanical energy to work pumps, boring-machines, stationary haulage engines, etc. Pumps are generally arranged on the same bed-plate with the motor, and geared up by two sets of ordinary spur-wheels. In some of the modern arrangements double-helical spur-wheels are used.

SAMUEL DAVIES.

FAN VENTILATION.

(3) We have two fans placed in connection with the upcast shaft; each fan is 25 feet diameter and 7 feet wide. When one is going at 50 revolutions per minute, 100,000 cubic feet of air is produced with a W.G. of 1·5 inches. What quantity and W.G. would be produced if the revolutions of the fan were increased to 80? If both were going together at 70 revolutions per minute, what quantity and W.G. would you expect, and if one was exhausting through the other how would the quantity and W.G. be altered?

Answer.—We have a fan producing 100,000 cubic feet of air per minute at 50 revolutions and 1·5 inches W.G. The speed of the fan is increased to 80 revolutions, find increased quantity and W.G.?

The quantity will be increased directly as the speed of the fan—

$$\therefore 100000 \times \frac{80}{50} = 160000 \text{ cu. ft. per min.}$$

The W.G. will increase directly as the square of the velocity of the fan—

$$\therefore 1 \cdot 5 \times \frac{80^2}{50^2} = 3 \cdot 84 \text{ ins. W.G.}$$

We have two fans working together at 70 revolutions per minute, find quantity and W.G.

One fan at 50 revolutions produces 100,000 cubic feet of air per minute, therefore, at 70 revolutions it will produce—

$$100000 \times \frac{70}{50} = 140000 \text{ cu. ft.}$$

When both fans are running together the quantity will be in proportion to the cube roots of the powers employed. In this case the powers will be as 2 : 1.

$$\therefore 140000 \times \sqrt[3]{\frac{2}{1}} = 140000 \times \frac{1 \cdot 2599}{1} = 176386$$

cubic feet per minute.

One fan at 70 revolutions will give a W.G. of

$$1 \cdot 5 \times \frac{70^2}{50^2} = 2 \cdot 94 \text{ ins.}$$

Therefore, the increased W.G. due to both fans working together will be in proportion to the squares of the quantities of air produced.

$$\therefore \frac{176386^2}{140000^2} \times 2 \cdot 94 = 4 \cdot 616 \text{ in. W.G.}$$

In the case of one fan exhausting through the other the quantity and W.G. would be very nearly the same as in the last case. We should probably get a slightly less quantity with a small increase of W.G., due to additional friction in one fan exhausting through the other.

JOHN WORRALL.

AWARDS

FOR ANSWERS TO COMPETITION QUESTIONS.

Question 1.—Thomas Watson, 3, East Hedley Hope, Tow Law.
Question 2.—Samuel Davies, Barrow Farm, Worsbro', near Barnsley.
Question 3.—J. Worrall, 21, Wigan Rd., Westhoughton.
Commended.—T. Lawrenson, H. Armstrong, J. Davies, W. Mycock, S. Micklethwaite, T. Martin, P. Haldane, W. Slocombe, R. W. Hall, W. Dickinson, J. E. Keefe, J. Stephenson.

EDITORIAL NOTES.

A general meeting of the members of the North of England Institute of Mining and Mechanical Engineers was held at Newcastle-on-Tyne, on October 12th. Mr. A. L. Steavenson in the Chair. The Secretary reported that the following gentlemen had been awarded prizes for papers contributed:—Messrs. F. Coulson, R. W. Moore, J. M. Main, H. Mellon, S. Tate, E. P. Wood, A. Siemens, J. Henderson, R. Russell, T. E. Eliven, W. O. Wood, and B. H. Thwaite. Discussion was resumed on the Report of the Flameless Explosive Committee—Part I., Air and Combustible Gases, and on Mr. Winkhaus paper, Experiments with Explosives. A paper was communicated by Mr. J. D. Kendall, on The Whitehaven Sandstone Series, the discussion of which was postponed.

* * *

The Council of the National Association of Colliery Managers have submitted to their solicitor a question as to coroners' inquests, and the right of persons to appear before the coroner to examine witnesses. The reply is that although the C.M.R.A. provides that a certain class of persons shall be entitled to examine witnesses, it does not fetter the coroner in his discretion as to allowing other persons to examine witnesses.

* * *

The Association have also forwarded a memorial to the Home Secretary, urging that the explosive experimental apparatus of the North of England Institute be taken over by the Government for officially testing explosives.

CORRESPONDENCE.

How is a Survey Plotted?

Sir,—I beg to submit the following in answer to "Ignorant," and I hope it will meet his wants. His request appeared on page 271, Vol. III. Fig. 5 is the survey plotted as he wanted, and I will endeavour to describe the mode of operation :—Pin the paper to the drawing board, and draw the magnetic meridian line N.S. on the paper, then fix a dot A on any part of it to denote the commencement of the work, apply the meridian line of the protractor to this assumed meridian with its centre on A, mark off the bearings as shown on fig. 2, then remove the protractor and measure the distance, 150 links, in the direction of A 1, having done so, take a parallel ruler and lay it on the paper in the direction of A 2, now move the parallel ruler up to the end of line 1 and draw a line, and measure the distance, 200 links, then take the parallel ruler and place it in the direction of A 3 and move it up to the end of line 2, draw a line and measure off 160 links as before; this is continued until the whole of the lines have been plotted. Fig. 2 shows the paper just after the protractor has been removed. Fig. 3 shows the survey joined, in pencil.

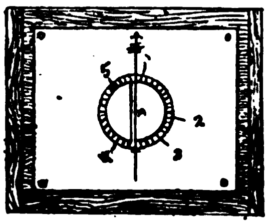

Fig. 1.

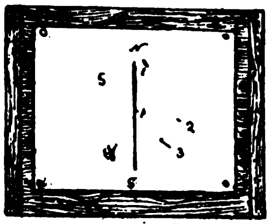

Fig. 2.

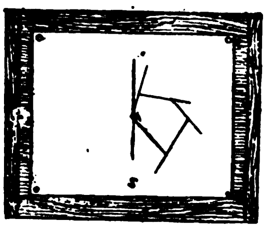

Fig. 3.

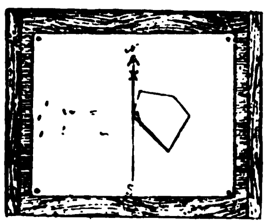

Fig. 4.

Fig. 4 is the survey completed with all superfluous lines removed, and inked over. "Drawing to a scale" means to draw on paper a copy or likeness of an object, the dimensions of the drawing being either the same or in direct proportion to the dimensions of the original object. (See page 74, No. 7, Vol. II, *Mining*.) The length of the lines of fig. 1 is determined by means of a scale or rule, which is divided into twelve equal parts along its edge, each part being equal to an inch in length. Each part is further sub-divided into ten equal parts, and when plotting with the one-chain scale the above is the one used; an inch equals one chain, and one-tenth of an inch equals ten links. To measure the length of the first line we would need one large division and five small ones. The second line would be two large divisions. The third line one large division and six small ones, and so with the others. There are other ways of plotting a survey which may be dealt with at some future time, for I think I have taken up sufficient of your valuable space for the present. If "Ignorant" wants any more information on plotting I am willing to do all I can for him or any other reader of your valuable journal.

JOHN N. WARDELL.

(We sincerely thank Mr. Wardell for his trouble and his willingness to repeat same if required.—Ed.)

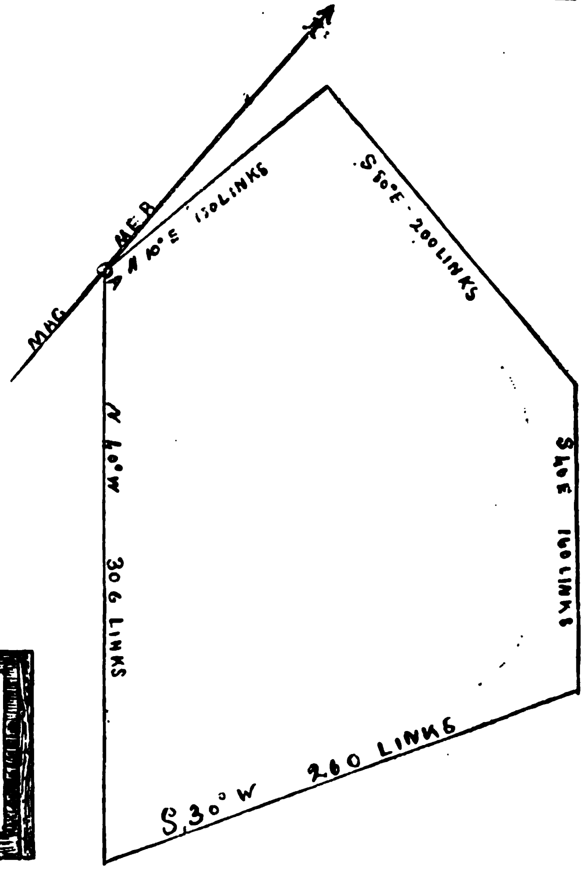

Fig. 5.

Size of Engines required for Winding.

Sir,—I have pleasure in giving my solution to the Competition Question *re* Winding Arrangements, an answer to which appeared in last issue. To wind 1,000 tons per day from a depth of 800 yards, capacity of tubs 10 cwt., required size of engine, &c.

Answer.—Steel cage, double-decked, holding six tubs, and weighing 2 ton 5 cwt. Each tub weighing 5 cwt. with capacity of 10 cwt. Working day eight hours, time per wind and change 1·4 minutes. Rope (extra plough steel) 5 inches circumference, weight 25 lbs. per fathom, with breaking strain of 108 tons. Boiler pressure 120 lbs., effective pressure 80 lbs. A pair of high pressure horizontal engines, cylinders 40 inch diam, 6 feet stroke. Drum cylindrical, 18 feet diameter, revolutions 42½ per wind, piston speed 510 feet.

H.S.

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MINING

A JOURNAL DEVOTED TO THE INTERESTS OF MININ

o. 26. Vol. III. SATURDAY, NOVEMBER 16, 1895. FORTNIGHTLY. ONE PENNY.

CONTENTS.

EASY LESSONS ON

MINE VENTILATION.

By J. CARTER, First-Class Certificated Manager.

(COMMENCED IN No. 9, VOL. III.)

THE following are a few examples with respect to fans:—

QUESTION I.—If fan making 50 revolutions per minute with 1·75 inch of water-gauge, suppose the speed of fan be altered so that the water-gauge read 2·75, what will be the speed of the fan?

The quantity of air varies as the square root of the water-gauge, and the quantity is in direct proportion to the speed of the fan. The speed of the fan also varies as the square root of the water-gauge.

$$\therefore \sqrt{1{\cdot}75} : \sqrt{2{\cdot}75} :: 50 : 62{\cdot}68 \text{ revs.}$$

QUESTION II.—A fan, running at 90 revolutions per minute, with a water-gauge of 4·25 inch, the speed of the fan is so altered that the water-gauge reads 2 inches. What will be the speed of the fan?

The speed of the fan varies as the square root of the water-gauge.

$$\therefore \sqrt{4{\cdot}25} : \sqrt{2} :: 90 : 61{\cdot}74$$

QUESTION III.—If a ventilating fan produces 30000 cubic feet of air per minute, what quantity of air will be produced if another fan of the same dimensions be added to it and worked with the same amount of power?

Quantity varies as cube root of power—

$$\therefore \sqrt[3]{1} : \sqrt[3]{2} :: 30000 : 37797$$

cu. ft. per min.

QUESTION IV.—If the horse-power of an engine is 45, and the water-gauge is 1·75 inch, what is the general efficiency of fans and what quantity of air would you expect?

Take the efficiency of a fan to be about 60 % of indicated horse-power of engine as realised in useful work done on the air, with an engine of 45 indicated horse-power, the horse-power in the air would be as—

$$100 : 60 :: 45 : 27$$

and to find the horse-power in the air the following rule is used:—

$$\text{HP.} = \frac{\text{Quantity of air in cu. ft. per min.} \times \text{W.G.} \times 5{\cdot}2}{33000}$$

$$Q = \frac{\text{H.P.} \times 33000}{\text{W.G.} \times 5{\cdot}2} = \frac{27 \times 33000}{1{\cdot}75 \times 5{\cdot}2} = 97912$$

cubic feet of air per minute, which is the quantity we may expect.

Fans are now coming more into general use for the ventilation of mines because of the many advantages which they have over the furnace. Appended below I give particulars of results at various collieries.

THE CAPELL FAN.—This is a fan which has been greatly improved by the inventor, G. M. Capell, whereby the power of the fan has been greatly increased. He placed the inner wings on an angle, which caused the air to be drawn screw-propeller fashion into the body of the fan. He then formed the

ends of these wings in the inlet into a scoop of special form, the portion nearest the centre (or at point of slower motion) presenting a larger collecting surface than that near the junction of inner and outer wings, to which the inner wings, set on an incline, gradually lead up the air.

The result has been to increase the power of the new Capell fan to an average of 30 % as compared with the well-known fans of the earlier patent. The gauge is also increased and the construction of the fan much simplified.

Fan on the above principle is now at work at Garswood Colliery, Wigan, of 17 feet 6 inches, double-inlet capacity, 450,000 cubic feet per minute, and 6 inches water-gauge.

Four fans of equal sizes under old and new types are placed in contrast for comparison:—

Capell fan (old patent), at Stanton Iron-works Colliery, near Mansfield. Diameter, 12 feet 6 inches; width, 11 feet; two inlets, 7 feet 6 inches; revolutions per minute, 215; water-gauge, 4·1 inches; cubic feet per min. increased in the returns, 199,500.

Capell fan (new patent), Allerton Main Colliery. Diameter, 12 feet 6 inches; width, 10 feet; two inlets, 7 feet 6 inches; revolutions per min., 215; water-gauge, 4·5 inches; cubic feet per minute, 240,000. The new fan has less width and gives more air and a higher gauge.

Capell fan (old patent, single inlet), Digby Colliery, Nottingham. Diameter, 15 feet; width, 5 feet 6 inches; inlet, 9 feet; revolutions per minute, 220; water-gauge, 6 inches; cubic feet per minute, 149,200.

Capell fan (new patent, single inlet) Hulton Henry Colliery, Wingate. Diameter, 15 feet; width, 5 feet 6 inches; inlet, 9 feet; revolutions per minute, 220; water-gauge, 6·14 inches; cubic feet per minute, 216,700. This difference of volume at the same gauge is very remarkable, being no less than 67,500 cubic feet per min., at a rather higher gauge, both fans being of equal cubical contents.

Results at various collieries of the Silent Guibal Fans (Cockson's patent):—

Wigan Coal & Iron Co., Ltd., Wigan, 30 feet diameter, 223,000 cubic feet at 5 inch W.G. (70 to 74 % useful effect).

Birtley Coal & Iron Co., Ltd., Durham, 20 feet diameter, 75,000 cubic feet per min., at 1·7 inch W.G. (63 % useful effect).

The Nunnery Colliery Co., Ltd., Sheffield, 8 feet diameter, 60,000 cubic feet per minute, at 3 inch W.G.

Andrew Knowles & Co., Ltd., Manchester, 24 feet diameter, 111,000 cubic feet per min., at 4·3 W.G.

Wigan Coal & Iron Co., Ltd. (Swire Pit, Standish), 24 feet diameter, 150,000 cubic feet per minute, at 5 inch W.G.

There are a number of various types of fans with improvements frequently being brought before us, and each claims some merit for their special type. There is no doubt whatever, from experiments made and the results obtained (a few of which I have given), that for ventilation, fans far supercede the furnace. They are safer, more economical, can be regulated, and will give a greater percentage of useful work.

In this article I have only given examples from the results of two types of fans, yet there are other fans which give good results. Fans with such advantages must have some claim on the attention of mining engineers and managers, in the future laying out of collieries. The depth of the shafts and the extensiveness of the workings of modern mines require the erection of good ventilators, otherwise the results obtained would not be at all satisfactory. Important as this subject is, I have endeavoured to lay down very plainly the laws of ventilation, and the examples given and worked out fully, cannot fail to be of some advantage to the persevering student, yet it must always be borne in mind that the results obtained in theoretical and practical ventilation do not work out alike, owing to the varied areas and rubbing surfaces of airways in mines. Besides this, they are constantly changing from various causes, such as falls, floor lifting, etc., which increase the friction, and as these irregularities vary so will the results. The best results will be obtained when the airways are of large area throughout and as straight as possible, because this reduces the resistance and, consequently, better results are obtained.

This concludes the series of lessons on Mine Ventilation, and the writer hopes the student readers of *Mining* have derived some advantage from them.

THE ENGINEERING OF COLLIERIES

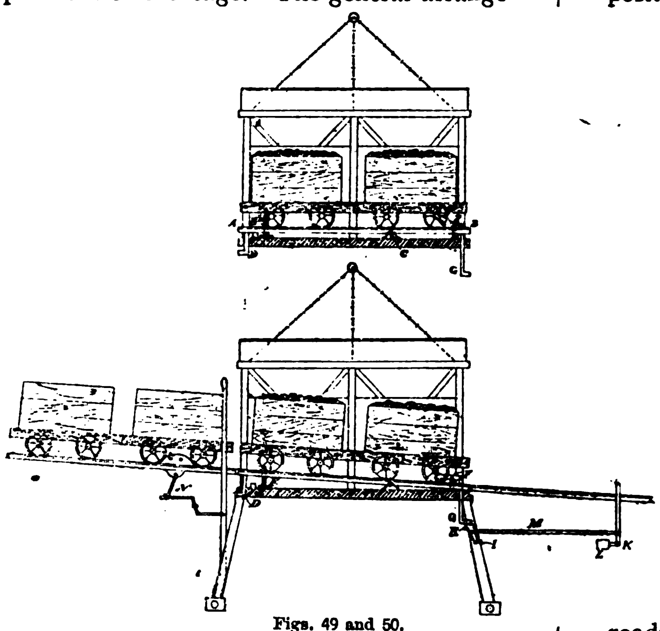
Being a Treatise on Colliery Machinery, Appliances, and Constructions.

By T. A. O'DONAHUE.

(COMMENCED IN No. 9, VOL. III.)

BANKING ARRANGEMENTS—AUTOMATIC CAGES.

FISHER'S CAGE.—A self-acting cage, designed by Mr. H. Fisher, has been adopted at several collieries in Nottingham and South Wales, and greatly facilitates the banking. The rails on which the tubs rest in the cage are automatically inclined immediately the cage rests on the keps and simultaneously the catches which prevent the tubs from falling out of the cage during winding are released, the full tubs pass out at one end of the cage, the empties run in at the other, and the tub-catch is again automatically adjusted before the empty tubs can pass out of the cage. The general arrangement of the appliance is illustrated by figs. 49 and 50, and although Mr. Fisher's design includes an elevating table for the empty tubs, it is altogether unnecessary, and a possible arrangement is shown without any avoidable complications. The rails (A B) on which the tubs rest are fixed a little above the bottom of the cage and are pivoted about the point C, which it will be noticed is not situated in the centre. To each rail, at the (A) end, is fastened a footpiece (D), the lower flange of which projects from underneath the cage bottom. During the time the cage is at bank the feet (D) rest on the keps and the rails are lifted up at that end, the full tubs run from the cage and the empties take their place. The empties are placed in readiness at bank on an inclined plane, where they must be retained in position until the cage arrives at bank. This may be effectually accomplished automatically by means of Woodworth's Tub Controller,* the actuating lever of which is connected to the lever which works the keps, so that the empty tubs are released at the same moment that the full tubs are running out of the cage. When the cage is raised slightly to withdraw the keps, previous to the cage descending, the feet (D) are no longer held up by the keps, and with the rails being pivoted a little from the centre the weight of the tubs causes them to again assume the horizontal position. To make the arrangement still more complete, automatic stops are added to keep the tubs in position in the cage during winding and to release them at bank. The necessary attachment for the end A of the cage may be very simple:—A vertical bar (E) fastened rigidly to the bottom of the *cage* and sufficiently long to prevent the axle of the tub passing it when the rails are in their horizontal position, but short enough to allow the axles of the tubs to pass when the rails are raised up, is all that is required, but a more elaborate arrangement is necessary for the end B. The stop at this end consists of a lever (F), to which is connected a footpiece (G). During the wind the stop is as shown by fig. 49, and engages on the axle of the tub, but at bank the footpiece (G) rests on a supporting piece (H), by which means G is raised up and the lever (F) allows the tubs to pass out. The supporting piece (H) is pivoted at the point I, and is connected to the bent lever (J K L) by a rod (M). The latter lever is pivoted at K, and the arm (J) projects up in the roadway along which the tubs coming from the cage pass, and is placed at such a distance that the axle of the first tub catches it as the last axle of the second tub passes over the lever (F). The axle of the tub passing J draws the piece (H) from under the footpiece (G), which by reason of its weight falls and turns F in time to catch the first axle of the tub coming in and prevents the tubs from running through. The weighted arm (L) of the lever



Figs. 49 and 50.

(* Described and illustrated in last issue.)

retains H in the correct position for supporting G when the cage is first brought to bank. It will thus be seen that all that is necessary to complete the whole operation of changing the tubs can be performed by one man actuating the lever of the keps, and the principal characteristic of the arrangement is that although labour is considerably reduced no mechanical power other than the ordinary winding engine is required.

In the modification of Fisher's cage, illustrated, the writer has substituted a permanently inclined road with Woodworth's tub controller for the empty tubs instead of the arrangement of elevating table, designed by Mr. Fisher, as being more economical in construction and working and much less complicated, though quite as effective. There is a little difficulty to be overcome, however, in the use of the tub controller for this particular work which has not been taken into account either in the description or illustration. In order to make Woodworth's tub controller automatic the actuating lever (N) must be liberated after releasing the tubs to allow the catch to fall back and prevent more than the required quantity of tubs passing.

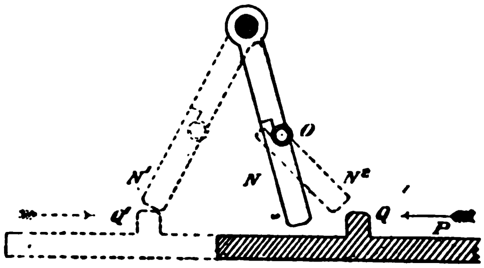


Fig. 51.

The manner in which the writer has arranged for this is shown by fig. 51. The actuating lever (N, fig. 50 and also fig. 51) is provided with a knuckle joint (O, fig. 51,) which will allow the bar to bend in one direction only. The lever (P) which is placed in connection with the lever of the keps is provided with a projecting piece (Q). When the keps are placed under the cage the lever (P) moves in the direction indicated by the arrow, and the projecting piece (Q) moves the bar (N) into the position shown dotted (N^1), thus working the controller and releasing the tubs. When the keps are properly adjusted under the cage the lever (P) is a little further in the direction of the arrow than shown, and the bar (N^1) in consequence slips over Q^2 and is at liberty to turn back into its original position when worked by the controller. When the keps are withdrawn the bar (P) is moved in the direction indicated by the dotted arrow, and in order to resume its original position the piece Q must first pass the bar (N). This is provided for by the knuckle joint (O), which allows the bar to bend into position N^2 and, when the piece Q has passed, to assume its original position in readiness for the next operation.

The cage arrangement may also be simplified by having the rails permanently inclined. If this was adopted it would be advisable to have a secondary stop for the tubs at the lowest end of the cage as an additional precaution against the tubs running from the cage during winding. The keps lever should then be placed at the delivery end of the cage so that the banksman could raise and lower the cage-catch as required as well as attend to the keps lever, thus increasing the safety without increasing the cost. The stop for the tubs on the entry side of the cage would also require modifying if the rails were permanently fixed; instead of having a rigid bar as shown, an ordinary weighted lever-catch as used for self-acting inclines would be necessary.

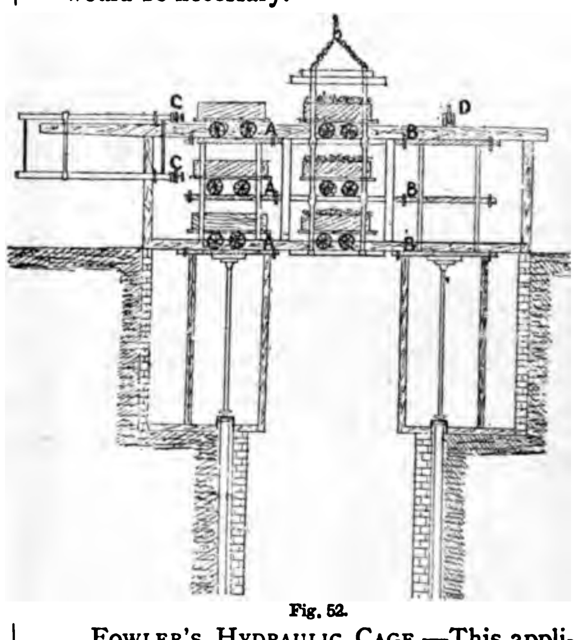


Fig. 52.

FOWLER'S HYDRAULIC CAGE.—This appliance is designed for quickly changing the tubs in treble-decked cages. All the decks are changed simultaneously, and with the aid of two subsidiary cages fixed on either

side of the winding cage the tubs are dealt with on one landing. Fig. 52 shows the arrangement. The subsidiary cages each consist of three platforms, one set (A) of which contains the empty tubs to replace the full tubs in the cage, and the other (B) is in readiness to receive the full tubs from the winding cage. The change is effected in the two upper decks by two hydraulic rams (CC) pushing the empty tubs forward and displacing the full ones at the same time that the change in the bottom deck is being effected by the workmen. The catches for retaining and releasing the tubs in the winding cage are worked by a rod as required. While the winding is being performed the subsidiary cages are lowered deck by deck to the bottom landing, the empty tubs being put on the platforms (A) and the full tubs taken from B. The cages are then raised and are placed in readiness for the return of the winding cage.

(*To be continued.*)

COLLIERY EXPLOSIONS.

THE WORK OF RESCUE AND EXPLORATION.

Written expressly for "MINING."

IT is a difficult task to attempt to lay down any fixed method of procedure after an extensive explosion. In every case the circumstances differ greatly, and what would be beneficial in one might prove highly dangerous in another. There are, however, a few points which remain the same in all these disasters and on which a hint or two may, in the writer's opinion, be useful.

There are few colliery managers, comparatively speaking, who have had much experience in this kind of work, but the writer having attended at some of the largest disasters of late years should be in a position to speak authoritatively on the subject.

The position of the colliery manager and of his subordinates after an explosion is by no means an enviable one. On them devolve the direction and the bulk of the work of rescue. It is, therefore, important that they should remain cool and collected, and see that everything is done without hurry and excitement and in a steady and methodical manner.

The first thing to be done is to ascertain whether the ventilating apparatus has been injured, as little can be done below without ventilation. If the colliery is so fortunate as to possess two fans, as is often the case, it is unlikely that both will be injured, and the reserve one should be put to work at once. Again, it is very rare that the fan or engines themselves are injured, the explosion generally expending its force on the covering of the drift and upcast shaft, blowing them into fragments. This should at once be remedied by covering the drift with planking and brattice cloth, kept down by any heavy material conveniently at hand. With upcasts that have a movable cover lifted by the cage there is generally to be found a spare one ready in case of accident to the one in use.

While these matters are being attended to, the winding apparatus, ropes, cages, etc., should be examined, and if the cages are broken too much to allow of descent in them they should be removed and some temporary appliance fitted up. A bowk or hoppit, a few of which generally lie about a modern colliery, can be employed for the time being, and smiths put to repair the broken cages or to construct rough ones for temporary use.

While preparations are being made for descending a good supply of brattice doors should be made. These consist of a rough frame of wood with a diagonal to stiffen them and brattice cloth nailed over, projecting on one side to form a hinge. There should also be provided rolls of brattice cloth, nails, a quantity of planking about 6 inches by 1 inch, and a number of stretchers, which are easily made of two pieces of wood, about 7 feet long, and a sheet of brattice cloth. Suitable timber should also be cut and placed conveniently near the pit top, posts from 3 to 4 feet high and 3 to 9 inches diam. being the most useful size, with plenty of wedges and lids from 9 inches to 12 inches long. No time should be lost in getting below, taking care that the shaft appliances are safe.

Signalling, if communication is destroyed, can generally be done by striking with a hammer on the cage or any iron in the shaft, and can be heard, according to the writer's experience, over 600 yards. A special code of signals should be adopted before making the first descent, and the engineman should lower very slowly in case there should be any obstruction in the shaft. Not more than three persons should descend the first time, and one should remain in the cage until it is ascertained that the inset is free from afterdamp. This is most important, as the writer remembers a case in which two men got out on the landing and were almost immediately rendered insensible. Fortunately the other man had prudently kept in the cage and

with great difficulty got them back into it. This shows that great caution is necessary, especially if the cage cannot go fully down to the bottom of the inset by reason of the debris. It is then very dangerous, as one may get down suddenly into an atmosphere too deadly to allow of retreat. The best plan in these cases is to lower a lamp by means of string and thus ascertain whether the bottom is clear. There is generally a good deal of clearing away to be done at the inset, as in most explosions it is the point where the maximum force is exerted. Trams, horses, timber, and rubbish are piled together in indescribable confusion, often blocking the way completely.

If there are boilers underground they are usually near the shaft, and an effort must be made at once to get to them and draw the fires, otherwise they may explode and cause further damage and loss of life, and the steam escaping from broken pipes is a source of danger to the explorers and renders it impossible to see or hear clearly. Once the shaft is got clear and the pit bottom free from afterdamp more help should be obtained. It is then advisable to station a man on the pit top, who shall enter in a book the name and address of every person descending the shaft, crossing them off on their return to bank. There is always a number of strangers rendering assistance, and as another explosion or a serious fall might at any time occur, it s advisable to know who is down.

Any survivors at the pit bottom should be attended to at once, and a supply of warm blankets, rugs, and stimulants sent down for their use. Medical aid should be procured as soon as possible, and when organising search parties it should be arranged for a doctor to accompany each party, provided with brandy, ammonia, etc. By so doing the writer has seen many lives saved which would otherwise have been lost. Artificial respiration should be resorted to in asphyxiated cases and kept up for at least half-an-hour after life seems to be extinct.

When sufficient help is at hand parties should be organised and despatched to each district of the mine, as far as the falls will allow. Each party should have at least one competent fireman with his lamp, a doctor, and, if possible, a person who knows the particular district, and failing the last, a plan.

If the return airways are clear enough from afterdamp a portion of the party should proceed that way, the rest taking the intake course. The returns never fall so badly as the intakes, and often prove to be the only means of access to the working faces. Again there is a tendency to take to the returns in these disasters, and many men are brought out alive this way. Care must be taken that Section 35 of the Coal Mines Regulation Act is observed until the arrival of the inspector of the district. As the first consideration is the rescue of any survivors little need be done in the way of clearing—a passage over the falls being all that is necessary. The short timbers from 3 to 4 feet are required in some places where the roof is still working, and where the doors are blown down they can be replaced by the brattice doors prepared for the purpose. Air-crossings can be quickly mended or even constructed with the 6 inches by 1 inch planking and brattice cloth before mentioned, the latter being lapped in between the planks to make them airtight. The writer has seen an air-crossing of this description put up in a little over two hours by a manager and two firemen.

Great caution should be exercised by explorers if the air is at all foul, especially in dip workings, and no person should attempt to proceed by himself, except under special circumstances, when it becomes a matter of personal enterprise. Some persons can work and breathe in an atmosphere that would be fatal to others, and when a human life is at stake the explorer must himself determine his course of action.

It is in this kind of work that the portable electric lamps prove so useful, as a man may go through any quantity of gas without fear of losing his light. A few of these electric lamps should be carried by each party if they are available, but it is not advisable to explore far with them as they give no indication of danger. When the effects of afterdamp are beginning to appear a retreat should at once be made, keeping as upright as possible and avoiding running or getting excited. If there is a Fleuss apparatus at the colliery, or even in the district, it should be sent for and prepared for use in case the afterdamp proves too strong in any place.

Often fire breaks out in some places and an endeavour must be made to extinguish or to isolate it. The timber in the locality and any inflammable material should be removed if practicable, and the fire may be checked by beating with coats and cloths if no water is at hand. In some cases it is recommended that dust be thrown on it, but as the dust of

a mine is essentially coal, it will, with any CH_4 that may be present, form a highly dangerous mixture, and will probably be ignited by the fire.

Water is the best means of getting the fire under, and a supply should be conveyed to the spot as soon as possible. Any pipes that may be in the shaft can be used as conduits, and if steam or compressed air is used the water can be taken along the roads in these pipes. Otherwise hose should be procured, or failing this, a chain of men must be formed and buckets passed from hand to hand to the scene of the fire. The various chemical and much vaunted fire extinguishers and grenades are absolutely useless in dealing with underground fires, the writer having seen several sorts put to a practical test, the general verdict being that a bucket of water was worth the whole lot.

After the mine has been explored and the survivors got out, the work of removing the bodies should be commenced. A label with a number should be affixed to each body by the exploring party for the purpose of identification and the enquiry. If the distance which the bodies have to be carried is long, plenty of help must be provided, and the bearers should relieve each other very often. Every person engaged in handling bodies should be provided with a pair of stout gloves, such as are used by masons. By neglecting this precaution several serious cases of blood poisoning have occurred. At this stage it is important that there be a plentiful supply of disinfectants as decomposition sets in rapidly in the heated atmosphere of a mine. Strong-smelling disinfectants are the best, such as Jeyes' fluid and carbolic acid, both diluted with water in large quantities, and chloride of lime. A good coating of Stockholm tar may be applied to the horses, arresting to some degree decomposition and allowing a little delay in their removal. When all the bodies that can be found are removed it is best to start at the pit shaft and clear away systematically, thus recovering any that may be under the falls.

As all the work is of a very arduous nature it should be arranged that the men work short shifts. There should be a good supply of substantial refreshments for them and plenty of stimulating drink. Many people have an idea that alcoholic drinks are not advisable to take during this kind of work, but the writer's experience is that they are just what are required. Hot coffee mixed with a little brandy or any sort of spirits, but particularly gin, seems to be the best. Beer is not of much use, although most men take it in preference to other drinks.

In conclusion, the writer begs to express a fervent hope that none of his readers will ever have cause to put these few recommendations to a practical test. However, the inevitable cannot be prevented, and whilst recognising the importance of preventing these fearful catastrophes an attempt must also be made to lessen the number of the victims. Most of the hints here embodied have, according to the writer's knowledge, been the means of saving many a life in recent explosions, and are not his own suggestions but matters of practical observation.

COMPETITION QUESTIONS.

We make an uniform award of 2s. 6d. to the sender of the best answer to each of the questions given. Answers to be as brief as possible, and sketches must be made when necessary. One or all of the questions may be answered.

Envelopes to be marked "Competition," and to reach us before November 29th, 1895.

We invite readers to forward questions for this competition.

(1) On a level road, 1200 yards long, it is required to draw 700 tons in 9 hours, the effective pressure is 35lbs., what size of engine, trams, rope, &c., would be required with the main and tail rope system?

(2) Describe and illustrate, by plans and sections, (*a*) the method of timbering where a branch road leaves a main road at an angle of 90 degrees, (*b*) how you would timber a main engine plane with a bad roof, (*c*) the method of timbering and pillaring the face of a gateway and two adjoining gateways, for a distance of 10 yards back, in longwall working, and show what is meant by a section of timbering?

(3) How would you clear a higher side goaf, which is 50 yards up, 100 yards wide, and full of gas, assuming there is a road at each end, and that there is sufficient air available?

AWARDS

For Answers to Competition Questions.

Question 1.—William Slocombe, 11, Thorne Avenue, Newbridge, *via* Newport, Mon.

Question 2.—J. Worrall, 21, Wigan Rd., Westhoughton

Question 3.—Samuel Davies, Barrow Farm, Worsbro', near Barnsley.

Commended.—M. Mowvley, J. Man, R. W. Walls, J. Scott, J. N. Wardell, J. Davies.

RAILWAY RATES ON COAL.

(Specially written for this Journal.)

CONTINUED FROM LAST ISSUE.

PART II.

The whole of the new Railway Rates and Charges Order Confirmation Acts of 1891 and 1892, came into force on the 1st January, 1893. On reciving their first carriage accounts for January, 1893, the traders discovered with something approaching dismay, that the railway companies were charging up to their *full maximum*, and that the result was, in many cases, seriously to increase the burdens of traders in respect to railway rates and charges, and, so numerous in fact, were the complaints, that in May, 1893, a Select Committee of the House of Commons was appointed to enquire "*into the manner in which the railway companies had exercised the new powers conferred upon them by Parliament.*" This Select Committee, which was presided over by Mr. Shaw Lefevre—after hearing a considerable amount of evidence from the traders on the one hand, and the railway companies on the other,—issued their second and final report at the end of December, 1893, the report being dated the 14th December. It was, on the whole, *in favour of the traders*, and it contained a recommendation to the effect that traders, who petitioned the Board of Trade, within a reasonable time, against any *increases of rates in 1893*, should have the right to take the opinion of the Railway Commissioners as to the reasonableness of such increases, *notwithstanding the rates did not exceed the maximum allowed to the Companies.* Following this report, traders, in large numbers, petitioned the Board of Trade, and, accordingly, early in the Session of 1894, the then President of the Board of Trade (Mr. Mundella) gave notice of his intention to introduce a Bill to carry out the recommendations of the Select Committee.

A correspondence which at that time took place between the Board of Trade and the Railway Companies Association, appeared in the press, in which the latter expressed their willingness to have the *reasonableness of the increases*—(thus admitting the increases),—decided by the Railway Commissioners, where an amicable settlement could not otherwise be effected.

The Government Bill was passed into law, and came into operation on the 25th August, 1894. Under it, subject to certain conditions, any trader who is aggrieved by reason of the increase of any rates, since the 1st January, 1893, is at liberty to call upon the railway company to justify the reasonableness of such increases, even although they may only have charged within their new maximum powers.

Many traders have availed themselves of the last-named Act, with the result that several cases have already been before, and many more are at the present time pending in, the Court of the Railway and Canal Commission.

So much for the question generally. With regard to the coal trade it may be affirmed that coal owners who are so deeply interested in the question of the cost of the carriage of coal, were much surprised at the action of the railway companies in having put up the rates previously charged—and especially was this the case in Lancashire. Formerly the rate for the carriage of slack, was lower than the rate for coal. It was admitted by the Railway Managers, both before the Board of Trade Tribunal and the Parliamentary Joint Committee, that this was properly so inasmuch as slack, was a much cheaper commodity, less than half the value of coal, and that it could not bear the same rate.

By the new Rates and Charges Acts however, slack is put in the same class as coal, and is therefore subject to the same conveyance rate.

Taking the case of Lancashire as illustrating the way in which coal owners have been affected by the new rates; the maximum rate on coal, in owners wagons, was formerly, one penny per ton per mile for any distance not exceeding 50 miles, and on slack, seven-eighths of a penny. Under the new Acts of 1891 and 1892, the three principal companies serving the Lancashire District are authorised to charge the following maximum rates on coal *and slack* in owners wagons:—

Railway.	For the first 20 miles or any part of such distance.	For the next 30 miles or any part of such distance.	For the next 50 miles or any part of such distance.	For the remainder of the distance.
	per ton per mile. d.	per ton per mile. d.	per ton per mile. d.	per ton per mile. d.
L. & N.-W.	0·95	0·85	0·50	0·40
L. & Y. / M. S. & L.	1·0	0·85	0·50	0·40

A station terminal of 3d. per ton at each end is authorised, but this charge can only be made where the stations belong to the railway company. In the case of coal traffic going from a colliery private siding to a

private siding at the destination end belonging to the consignee, no station terminal would be payable at either end.

With regard to the conveyance rate on coal it will be seen that whilst in the case of the L. & N.-W. Company, the former maximum rate of one penny per ton per mile for the first 50 miles, has been altered to 0·95d. for the first *20* miles, the conveyance rate on slack has been altered from seven-eighths of a penny per ton per mile for the first 50 miles, to 0·95 for the first *20* miles, so that whilst the initial rate for the conveyance of coal has been slightly reduced the corresponding rate for slack has been increased. In the case of the other two companies whilst the initial rate for coal remains at one penny per ton per mile, the rate for slack has been increased an eighth of a penny per ton per mile.

This increase has been made notwithstanding the fact that the railway managers repeatedly stated in their evidence before the Board of Trade Tribunal and the Committee of Parliament, that it was ***not their intention to increase the rates.***

As a matter of fact the two last named companies do not charge in excess of the 0·95 when they carry in competition with the L. & N.-W. Railway Company, but it will be seen that the increase in the initial conveyance rate for slack, from 0·875 to 0·95, is a serious increase on the carriage of that commodity, and obviously those coal owners who send large quantities of slack to chemical works and other manufactories are heavily taxed. This increase in the conveyance rate for slack is the most serious matter the coal owners have to complain of, but there are other directions in which the former rates have been advanced. Under their new powers the Railway Companies—where they can do so—are charging their full maximum, whereas formerly on the longer-distance traffic especially, they did not charge up to their full powers. Thus where under the new acts the maximum rate for coal has been slightly decreased, the ***actual*** rates charged are frequently in advance of those formerly charged. Then again coal traffic used in many cases to be carried and charged for at 21cwt. to the ton, whilst under the new acts all rates are calculated on the statutory ton of 20cwt., but with an allowance of 2cwt. per wagon—(eight or ten tons, as the case may be)—for wastage. The new acts provide that all weight,—except as to stone and timber,—is to be calculated on the imperial avoirdupois, and no complaint could reasonably be made of this, but it will be seen that by the abolition of the "long ton," an indirect increase has resulted in the conveyance rate. This question has recently been the subject of three actions before the Railway Commissioners, judgment having been given for the traders, to the effect that the increases were not wholly justified. Another way in which the former rates on coal traffic have been increased has been by the duplication by the Railway Companies of the *short-distance* charges.

The new acts provide that in the case of traffic going from a private siding to a private siding, for any distance under six miles, the companies may charge the maximum conveyance rate as for six miles, and traffic passing under the conditions just named, for any distance, however short, would be liable to a rate as for ***six miles.***

In the case of traffic going from a private siding to a station belonging to the railway company, any distance under 4½ miles, it is liable to the rate as for 4½ miles; and in the case of traffic going from a railway company's siding to another siding or station of a railway company, the short-distance power is reduced to three miles. In many cases traffic requires to pass over the lines of two or more companies to reach its destination, and if it happens to have to pass for only a short distance over the lines of one or more of the companies, the short-distance charges are enforced, and in this way, in many cases, the rate for conveyance becomes prohibitive.

It is against all these increases that the coal owners, in common with other traders, complain so loudly.

They contend that the Railway and Canal Traffic Act of 1888 was intended to be an Act for the relief of traders, and that it never could have been in the contemplation of the legislature that the Act should result in rates and charges being increased.

It is claimed further by the traders that it was clearly intended that a trader should be entitled to ask from the railway company at his door, for a ***through rate*** from his works or colliery, to the place of consignment, and that the railway companies are not entitled to duplicate the short distance charges. It is the railway company on whose line a colliery or works is situate that quotes the rate, and is liable to the consignor for the safe carriage of the merchandise traffic entrusted to it, and it is to that company that the consignor is liable for the payment of the toll accounts, and in such a case he has no concern or dealings with any other railway company.

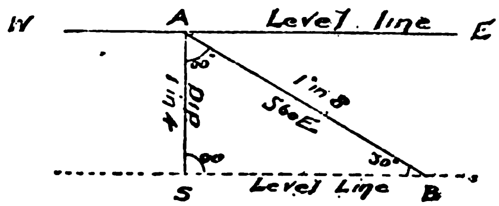
(*To be continued.*)

ANSWERS TO COMPETITION QUESTIONS

In No. 23, Vol. III.

SURVEYING.

(1) The level course of a bearing is exactly E and W. and the dips due S 1 in 4. A road is started away at 1 in 8, find its bearing. How often do you consider it necessary to check meridian lines?



Answer.—To understand the pith of the above question, we cannot do better than to construct a diagram to illustrate our meaning in this way:—Description: Suppose S to be 1 yard below A, then A S is 4 yards long, as the gradient is 1 in 4. The point B has also to be 1 yard below A, and on a level line with S, therefore A B will be 8 yards long, as the gradient in this case is 1 in 8. Now A B is twice A S, therefore the angle S A B = 60° and A B S = 30° ∴ bearing A B will be S 60 E. Meridian lines should by all means be checked at least once every year at all collieries; because the declination of the needle varies on an average about 7 minutes each year. S. Davies.

THE EXTINGUISHING OF FIRES UNDERGROUND.

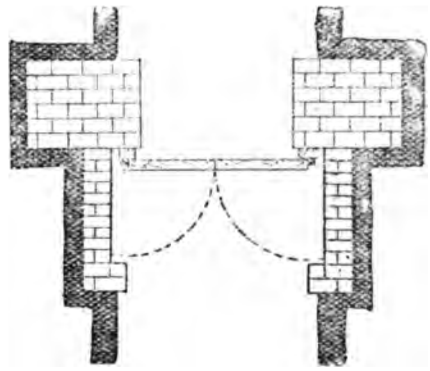
(2) How would you extinguish a raging fire in the main intake airway half a mile from the downcast, there being a clear way to the fire. Assuming that there are 50 men working beyond the fire, explain how you would endeavour to get them out as soon as possible?

Answer.—The first duty would be to get all the men safely out of the mine if possible, and for this purpose a gang of men who are perfectly acquainted with the airways should be despatched by the returns to the far end to see that all the workmen are out of their places and conduct them to the shaft. It would also perhaps be advisable to partly open the separation doors so that the full current of air would not play on the fire (of course presuming that the doors were between the downcast and the fire). This would also prevent the fire spreading so rapidly, and at the same time there would not be as much smoke for the men on the return side of the fire to contend with. I should have the men pass through these doors and ascend at the downcast shaft, as they would then be on the right side of the fire. Having got all the men safely out of the mine the next operation would be to extinguish the fire. I should have the separation doors propped wide open and the fan slowed down. I should then have a temporary stopping built in the return airway and made as airtight as possible. I should also have another stopping erected on the intake side near the fire, but made so that the men engaged in the operations could readily pass through it. The object of these stoppings would be to exclude the air as much as possible. The men would then play on the fire with water, portable fire extinguishers, hand grenades, &c. At some collieries water pipes are laid from the surface or from some upper seam to the shaft bottom, and along the main intake airway. These pipes are usually supplied with taps or cocks at intervals. If these conditions prevailed, in this instance, I should have hose pipes attached, and the water played on the fire. If the above operations failed it would be necessary to exchange the temporary stoppings for good strong ones built of brick or stone, and filled between with sand so as to be airtight. A pipe should be built in the stopping on the intake side and carbonic acid gas forced through into the fire. This gas can be produced by pouring hydro-chloric acid upon broken limestone enclosed in strong lead-lined boxes to resist the acid. If this plan also failed to extinguish the fire the only resource open to us would be to flood the mine, but this should only be resorted to when all other methods have failed. In cases of this sort many lives have been lost through the workmen not knowing the route to the shaft by the return airway. It has been suggested, and I think the plan ought to be generally adopted, that the workmen should travel through the airways now and again so as to make them acquainted with them. Notice boards should also be fixed at any junctions to guide them in the right direction.

John Worrall.

VENTILATION AND RESERVE DOORS.

(3) How would you put up a safety door, or a reserve door, to be available directly after a severe explosion had happened. What in your opinion is the best method of fixing doors, having regard to a possible explosion?



Answer.—In the first place I would put up a safety door between the main doors on all important cross-cuts between the intake and return airways. This reserve door would be put up the same as the others, but the masonry would be different, inasmuch as the side walls would be continued back to beyond the point the door reaches when open. In the side walls I would make a recess for each door to open into, and the door should be kept open and bolted back into the recess with an ordinary slip bolt. In case of an explosion this door being open, and in a recess of strong masonry, escapes the force of the blast, and is available for use by merely pulling back the bolt, and thus the ventilation could be quickly rearranged. In my opinion the best method of fixing doors is as follows:—The sides of the road should be shorn back until fairly solid, a foundation taken out, and a solid masonry block built in, at least 3 feet thick, leaving an opening for the roadway 5 feet wide and 6 feet high. Binders of wood must be inserted in the masonry at intervals, and to these the frame of the door is clamped, and the joints well mortared all round. The door should be made in two halves, fitting together at the middle of the opening as shown in the accompanying plan, as when so made they are easier to handle, the hooks are not strained to the same extent, therefore the door does not get out of order so quickly. To fulfil the requirements of the C.M.R.A., the door must be fixed so as to fall and close of itself. This is done by putting the lower hook back a few inches out of the vertical line with the top one, and increasing the length of the lower eye accordingly. By this means the door is canting inwards at the top, and if loose it will fall to by its own weight. In case of an explosion, if the force came from the return towards the intake, the doors would be blown open, and if not blown down would fall back into position of themselves. The plan shows this method of fixing reserve doors. The recesses formed by the side walls are unnecessary for the ordinary doors. In our colliery which is an extensive and fiery one, the foregoing methods are exclusively employed. WILLIAM SLOCOMBE.

CORRESPONDENCE.

CHAVETTE'S METHOD OF SINKING.

Sir,—I should be glad if any of your readers would assist me with information and sketches *re* Chavette's method of sinking through quicksand. A. E. D.

SYLVESTER'S ARTIFICIAL RESPIRATOR.

I would also be obliged for information *re* the above. A. E. D.

THEORETICAL MECHANICS.

Sir,—Will some of your readers please answer the following question:—A weight of one ton is let fall through a space of 6 feet, what will be the blow on the ground in lbs. or tons, not foot pounds. T. JAMES.

GEOLOGY.

Sir,—I should be pleased if you would kindly insert the following in your valuable paper to be answered by some of your willing contributors, and you will greatly assist a beginner:—(1) A fault at the north crop is a dipper, W 100 yards, and at the south crop a dipper E 80 yards, give reasons for this. (2) How do you account for the greatest dip at the crop and flat at the centre of the basin. T. B.

PUMPING.

Feeders of water are met with 150 gallons at 120 yards, 300 gallons at 300 yards, and 150 gallons at 500 yards. Describe the pumps you would employ and how you would deal with the water. T. B.

EDITORIAL NOTES.

Our special articles this issue are "Railway Rates on Coal" and "Colliery Explosions," both of which are written by persons who are authorities on the respective subjects.

* * *

This number concludes Vol. III, and particulars *re* index, binding cases, and the binding of volumes will be found on last page of cover.

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Attempts to isolate and extinguish gob fires cannot be attended with too much care, as the work is extremely dangerous. While building a wall round a "gob" fire at the Oldfield Colliery, Longton, on Oct. 29th, nine men were overcome by the fumes. A rescue party was formed and at great peril conveyed the men to a place of safety, but it was found that two of the miners had succumbed.

COLLIERY MANAGERS.*

By Mr. M. WALTON BROWN.

THE colliery manager of the present, and more especially of the future, must be a man of education, and, as time advances, the requirements of his profession will become more and more exigent. A colliery manager cannot accept theories which he does not understand; his education must be exact and thorough, otherwise he will be classed as a workman, and not as a professional man. The management of mines must be more efficient in the future than it has been in the past, and the individual must become part of the profession.

The education of a colliery manager is necessarily very comprehensive. As a schoolboy he should acquire a knowledge of several modern languages, in order that he may hereafter be able to read the valuable works on mining published in other countries; and if he can also acquire a little Latin or Greek, it will certainly prove useful to him in his profession.

A knowledge of mathematics and the physical sciences is essential in utilising the forces and directing them to the service of mankind. He should, therefore, acquire a knowledge of geology, physics, chemistry, and every science appertaining to his profession. He need not endeavour to acquire more than the general principles of these sciences, so that he may know where to find detailed information when required, and to follow the present rapid development of knowledge in all its branches

A colliery manager is required to apply machinery to multitudinous purposes. He should have a knowledge of the nature and strengths of building materials, so as to utilise both material and labour in the most efficient manner.

Geology is the essential study of a colliery manager, being utilised in directing the search for minerals, and the miner has often assisted the conclusions of the geologist. Water supply and surface drainage are now becoming prominent questions for satisfactory solution.

Heat is studied in relation to the efficiency of steam and other heat engines. Cold is used for the freezing of water-bearing rocks. Compressed air is used for working pumping, coal-cutting, rock-drills, and other machinery. Coal is distilled for the production of coke and lighting-gas, and the bye-products should all be utilised. Electricity is used as a source of light, for the working of fans, pumps, and other machinery, for the ignition of explosives, for signalling, and many other purposes. High explosives are likely to play an important part in coal mining of the future. The prevention of smoke still awaits the invention of an efficient remedy. Variations of temperature and pressure of the atmosphere may give warnings of possible issues of gas in mines. Calculating machines, such as the slide-rule, the planimeter, &c., lighten the labour of calculation.

The preceding remarks only convey a slight notion of the aids afforded by the sciences to the colliery manager. The colliery manager should especially study mankind, political economy, and statistics, so that he may be able to decide upon the commercial advantages of any mining enterprise, and to secure the confidence of those who may have to base their decisions upon the results of his plans and estimates. He should be competent to draft the details of the necessary works, the capital required for their execution, the costs of working, and to substantiate his views before unfriendly critics.

The practical colliery manager affects to despise technical training and all scientific results or theory; but he constantly, consciously or unconsciously, applies theory to all the items of his duties. Theory is merely the expression of the results of experience made available for application under similar conditions, and, however practical a colliery manager may be, reason leads him to form opinions, or theories, based upon the results of his actual past experience. It is certain that the success of the "practical" manager is dependent as much upon the application of scientific theories as that of the manager who may have received a scientific training and served a term as an apprentice to his profession.

The old-fashioned colliery manager achieved successful results by sound common sense, shrewdness in acquiring knowledge, and from his capacity, to manage workmen and to select qualified assistants. These qualifications are still essential to the successful management of collieries, accompanied with scientific knowledge based upon youthful training in mathematics and the physical science.

* Extracts from Presidential address delivered before the North of England Branch of the National Association of Colliery Managers.

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